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THE CIPHER OF ROGER BACON

WILLIAM ROMAINE NEWBOLD
1865–1926
The Portrait by Joseph Sacks

WITHDRAWN

THE CIPHER OF ROGER BACON

By

WILLIAM ROMAINE NEWBOLD
Late Adam Seybert Professor of Intellectual and Moral Philosophy, University of Pennsylvania

Edited with Foreword and Notes by

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As a tribute to their classmate

WILLIAM ROMAINE NEWBOLD

of the
Class of 1887
University of Pennsylvania

this volume is published on
the Fund established by
the members of
the class

[The technical terms which Newbold adopted in connection with the cipher of Roger Bacon are all explained in the text of Chapter VI, except *commutation*, which is in Chapter VII.]

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FOREWORD

William Romaine Newbold was even as a boy attracted by strange alphabets and puzzling methods of writing. He was thrilled by Layard's *Nineveh*; he copied with a stylus on soft clay a cuneiform text there pictured, baked the tablet in the kitchen oven, and buried it in a field, where some day it may be found and held as proof of an Assyrian conquest of Northern New Jersey. He taught himself to read the Hebrew Old Testament; any word which he had to look up in the Dictionary he underlined. I have seen the copy which he used; half way through, there are often ten or twelve pages in succession unmarred by underlining. When he reached the Aramaic sections, the book of *Daniel* and part of *Ezra*, he was without aids, but worked out his own grammar of the dialect. He entered the sophomore class of the College at the University of Pennsylvania in 1884, and gathered around him a group of classmates whom he introduced to the elements of Hebrew; one of them is among the most distinguished Semitists of our country, and has an international reputation. He persuaded the late Morton W. Easton to offer a a course in Sanskrit, the first ever given at the University of Pennsylvania, and pursued its study for two years, in a group which started with twelve members and ended with two.

As an undergraduate he stood easily first in every subject in a class which included a number who have since then won distinction in scholarly and in public life. After graduation he devoted himself to teaching and to study, specializing in Greek and in Philosophy; he became interested also in Psychology and in Spiritism, and was one of the group who in the last decade of the nineteenth century made an intensive investigation of spiritistic phenomena. Presently he returned to Philosophy, and made himself a master of the Greek theories; the early philosophers, Plato, Aristotle, these found in few men of modern times a keener and more sympathetic interpreter.[1]

[1] A complete bibliography of Newbold's writings was printed as an appendix to the *Proceedings of the Newbold Memorial Meeting*, held on December 1, 1926; a few copies still remain for free distribution, on application to Prof. Roland G. Kent, Bennett Hall, University of Pennsylvania, Philadelphia.

Newbold's mind was not content to remain in any single limited field. From the Greek philosophies he ranged out into their later manifestations and into the history of Christian thought. Neo-Platonism, the Gnostics, Valentinianism, all claimed his attention. The newly-discovered Syriac Odes of Solomon fascinated him; he learned Syriac, and made important contributions to their interpretation.[2] In 1920, he delivered a course of lectures on *The Valentinian Gnosis*, on the Bohlen Foundation, in Philadelphia.

It was just before this, in 1919, that his attention was drawn to the remarkable cipher manuscript which had been discovered by Mr. Voynich and had been by him attributed to Roger Bacon. Receiving a few photographs of pages, among them, fortunately, that of the Key to the cipher, Newbold applied himself to its decipherment with the same exuberant zeal which characterized all his scholarly investigations. It was his habit to work far into the night, till one or two or even three o'clock, and then to sleep in the afternoons; his note books and worksheets are often annotated with the hour when the problem is finished, and "1.45 A.M." is as likely to be found as "11.20 A.M." In 1921 his work had progressed far enough for him to make some public announcement. On the evening of April 20 he lectured on the Mary Scott Newbold Foundation, at the College of Physicians of Philadelphia, on "The Voynich Roger Bacon Manuscript," before a large audience, containing many scholars from distant parts of the country. On the next afternoon he lectured before the American Philosophical Society on the same subject, taking up the more technical subject of reading and decipherment. A few weeks later he lectured on the same subjects at the Universities of Nebraska, Michigan, Wisconsin, and Chicago; and then and later he spoke before many organizations in and about Philadelphia. In June, he received the honorary degree of LL.D. from his Alma Mater, the University of Pennsylvania.

But Newbold's interests were too wide for him to tarry long with a single subject. His studies in the development of early Christian thought brought him an invitation to lecture at the General Theological Seminary of the Protestant Episcopal Church, in New York City, in 1923, and again in 1925. He had always been deeply interested in Christian archaeology also, and his frequent

[2] *Bardaisan and the Odes of Solomon*; in *Journ. of Bibl. Lit.*, XXX 161–204 (1911); *The Descent of Christ in the Odes of Solomon*, in *J. B. L.*, XXXI 168–209 (1912).

visits to Rome had given him unusual opportunities to familiarize himself with recent discoveries. The finding of the Great Chalice of Antioch, supposed by some to be the actual Chalice of the Last Supper, the Holy Grail of legend, commanded his attention, and he devoted much time to it, the fruits of his study appearing in two published articles.[3]

In the course of these studies he came upon certain inscriptions written in Latin letters, but unintelligible as Latin. With his command of Semitic dialects, he recognized them as Aramaic written in Latin characters, and published them. But this was his last study: the issue of the *American Journal of Archaeology* in which it was printed, was received by subscribers in the week after Newbold died.[4]

A mind like Newbold's, interested in everything, found it impossible to limit itself to a single field of knowledge. One day, traveling to New York, he engaged his neighbor in conversation and found him to be a stock-broker; and so learnedly did he talk of stocks and bonds, and of the conditions of finance, that the stock-broker presently asked him with what brokerage house he was connected; he was appalled to find that Newbold was a professor of Philosophy, and of Greek Philosophy, at that. The sketch that I have given of his varied and changing interests is still deficient; for Newbold was an expert in genealogical research, he had in an earlier period shown high administrative qualities as Dean of the Graduate School of the University of Pennsylvania, and as a prodigious reader he had no small store of knowledge in almost every field of human endeavor.

I mention this because it explains in great measure why he never himself completed the volume on which he was working, an account and an exposition of the Cipher of Roger Bacon. And his slowness at the work is even more intelligible when we realize the nature of the task which was before him.

What then is this manuscript which has roused this interest and which busied Newbold for so many months and years? It is one of a number of manuscripts purchased in or about 1912 by Mr. Wilfrid M. Voynich, the well-known London and New York specialist in

[3] *The Great Chalice of Antioch*; in *Ladies Home Journal*, November, 1924, pp. 8 ff. *The Eagle and the Basket on the Chalice of Antioch*; in *American Journal of Archaeology*, XXIX 357–380 (1925).

[4] *Five Transliterated Aramaic Inscriptions*; in *Amer. Journ. Arch.*, XXX 288–329 (1926).

rare books and manuscripts, and identified by him as being of the thirteenth century. A number of the leaves had been removed, but the equivalent of 232 quarto pages still remain. Many of the pages contain beautifully colored drawings of natural scientific character, which at once limit the authorship to a very few possibilities, the most likely of them being Friar Roger Bacon, who lived from about 1214 to 1294, and was possessed of scientific attainments far ahead of his times. Even more striking is the fact that the writing is entirely in unknown characters, showing that some form of cipher had been used; and it is well-known that Roger Bacon was an expert in ciphers.

Mr. Voynich in 1912 exhibited this manuscript to French scholars in Paris, and in that year and in the following year to English scholars also; but no progress was made toward the interpretation. Shortly afterward he brought the manuscript to this country, where it still remains. He distributed photographs of the more interesting pages to many scholars, in the hope that someone might find the key to its reading; but no one made any progress, except Newbold.

Newbold, though not an expert in ciphers,[5] did not give up easily, for he had become fascinated with the task. He was stimulated by his early discovery that the final page of the manuscript, of which he had received a photograph, contained the Key, and if he could read the Key he could read the cipher. In this Key were the Latin words *michi dabas multos portas*, which, if we correct *multos* to *multas*, means "Thou didst give me many doors *or* gates." But these letters were themselves separated by meaningless groups of letters, and later in the Key some words in English of the time of Roger Bacon were discernible. Newbold took a simplified alphabet of twenty-two letters, and putting it alongside the Latin phrase, he got a set of equivalents from which he ultimately worked out the superficial significance of the Key and thereby a sure foundation for further work.

[5] Newbold later became very expert in ciphers. On May 5, 1922, Theodore Roosevelt, Assistant Secretary of the Navy, wrote him the following letter: "The Director of Naval Intelligence has informed me that you have been of very great assistance to his office in giving your time and trouble in deciphering espionage correspondence that had baffled the Departments here in Washington. It is expected that these documents will prove of great value in the Government's investigation of influences working to our detriment. I wish to thank you most heartily for this assistance. . . .

"PS: What you have done suggests the most interesting parts of Sherlock Holmes."

In the course of this he noticed that certain letters, though apparently the same, contained real differences, and were made of several short lines, slightly separated. In view of the great uniformity of manuscript writing, which is almost like print in this respect, he realized that this had its significance. After a long study of many fields, he discovered that the manuscript was written in characters which were themselves made up of smaller characters, often microscopic, based mainly on ancient Greek shorthand. But the difficulties were not yet ended, for the tiny characters were often almost superimposed one upon the other, and a blot of ink was often smeared over them, so that the blot appeared to be accidental; or a light line was drawn through several characters, giving them the appearance of a single heavy line until careful inspection in a strong light or the holding of the photograph to a strong light which shone through it, revealed the presence and the identity of the separate characters.

Further, many pictures were formed largely of these characters, skilfully arranged; even the letters in the Key itself were composed each of a number of characters, giving (as he later discovered) a description of the cipher.

It was long before Newbold surmounted these difficulties and began to get valid results. His account of their solution will be found later, in Chapters VII and IX especially; let us here pass them by, and see what the nature of the cipher is.

Bacon first simplified his alphabet to eleven letters, A P C T E I R M N U S, each representing itself and kindred sounds: P stands for *b* and *f* as well as for *p*; U stands for *o* and for *v* as well as for *u*; and so on. These letters now received biliteral values: that is, as there are 484 possible combinations of the 22 letters of his longer simplified alphabet, or 529 combinations if it consisted of 23 letters (as Newbold came to believe just before his work came to its untimely end), every letter of the eleven-letter alphabet received a number of values expressed in two letters each. The C was expressed by *go*, by *gr*, by *ar*, and by other groups. In this way, the word *cat* might be expressed by *gr-ad-ed*. But such writing doubles the number of letters and thereby the amount of space needed, and also eliminates the use of any combinations containing an uneven number of letters. It would be more convenient to write *cat* by *go-ol-ld*, and to shorten this to *gold* by omission of the duplicated letters.

Of course, for the shorthand cipher of the Voynich Manuscript, it was not necessary to form words with actual meanings, as has just been done. But the method of the cipher is better seen through such an explanation. And besides this, in the course of his work, Newbold discovered that certain other writings of Roger Bacon, apparently in Latin with a meaning, were really written in this cipher, a surface text which seemed to give a meaning being secured by the device just explained. But in such a text it was not easy to make words in this fashion and string them together so as to give an apparent text. Other devices had to be adopted. So *cat* might be written *ar-rk-da*, or, with rearrangement, *da-ar-rk*; and, with omission, *dark*. Thus on deciphering *dark*, we get *tca*, which must be rearranged to *cat*.

In the reading of the Voynich Manuscript, the process of decipherment is as follows: A place of beginning must be found and then the minute shorthand characters must be identified and transcribed in order, and transliterated into ordinary letters. It is of prime importance to get them in their proper order, for the second step is to double every one but the first and the last, and then to divide them into pairs; and if there are any errors in the order it will introduce errors in the series of pairs. The next stage is to "commute" or change every letter which in its pair stands next to any one of the letters in the Latin word *conmuta*, or to *q*, which seems here to be an equivalent of *c*. Then each pair has to be translated into its "alphabetic" value, which is next translated into its phonetic value. These last three steps can be combined into one, of course, since the phonetic values of the uncommuted pairs can be calculated and drawn up into a table. But by this decipherment we now have a meaningless string of Latin letters, belonging to the eleven-letter alphabet; some of them have alternative values, making further confusion. These letters must be rearranged so as to form a Latin text.

Newbold always claimed that this was in many cases not so difficult as it seemed, since on looking at the first eight or ten letters he soon saw the letters forming some Latin word; when that had been taken out, he carried on the slight remainder to the next group of letters, and repeated the process. The possibilities of such rearrangement seem too many for any certainty in the results; but when I asked Newbold if any Latin text would not yield results

by this method, he said that he had tried it with several of Bacon's works which were obviously not meant to be in cipher, and while he could form Latin words for a time, he was soon left with unmanageable groups of consonants. This forbade all idea of continuing the experiment, since Latin words require between forty and fifty per cent of vowels.

This brief account will perhaps make easier the understanding of the detailed account of the same processes given by Newbold in Chapters IV, VI, VII, and VIII. But the decipherment of the apparent Latin texts is in some respects simpler than that of the shorthand text of the Voynich Manuscript. For in the Latin texts there is no problem of identification of the microscopic signs, and the order of the letters is apparent to the eye. It is necessary merely to double all but the first and the last letter of every word, and to give to the biliteral groups their values *without commutation.* The process of rearrangement is the same as with the shorthand text.

It is easy to see that, in working with a cipher of this sort, progress is slow, painfully slow. Scores, perhaps hundreds, of sheets with trial alphabets scribbled on them testify to the laborious nature of the task. We must remember that it was with the Voynich Manuscript that Newbold began his work; and that this is ultra-difficult because of the nature of the writing: microscopic characters in a modified Greek shorthand. Extracts from letters of which he preserved copies give some idea of his progress. Thus on February 7, 1920, he wrote, "The first objective verification came last September," eight months after receipt of the photostat of the Key, "when I discovered that application of my trial alphabets to the mysterious interpolations in the Key Sentence, *ton ola te tccr cerc*, yielded the letters R B . C O N I," from which he suspected that *te* had the value of A, as indeed was proved later to be the case.

At the same time he wrote, "Study of the cipher characters early convinced me that they constituted no true alphabet, or at least that many of them were composed of significant elements. I began a search for the source of these elements; got the ciphers of Ethicus and Artephius, both mentioned by Bacon, and examined many other mediaeval ciphers as well as the Tironian signs, but all with no success at all. Then I bethought me of Greek shorthand, and there I found them, or nearly all of them. Those that do not belong to

that system are few—some Roman letters, some of the customary abbreviation signs, and some the origin of which I cannot trace. He also uses a dot as a diacritical sign much as *daghesh* is used in Hebrew, but I have not yet encountered any Hebrew letters." This was, as one may see, written not exclusively with regard to the cipher of the Voynich manuscript, but has to do also with the Latin type of cipher; one Hebrew letter, *beth*, he found later in the Vatican Document (Chapter XVI). He goes on:

"But such is the craft, may I say the infernal craft, of the dear old soul, that long after I had his alphabet and his system I could not read a word with any assurance that it was right. And I haven't yet mastered all his tricks, although I know a great many of them.

"*Deception* is the keynote of the whole. Nothing is what it seems to be. His beautifully written characters are all shams. They look like *a*, *s*, *m*, *n*, and so on, but they are nothing of the kind. Nearly every one is built up with amazing skill and ingenuity out of microscopic shorthand characters. He was the only man on earth possessed of a good microscope, and he relies upon it as part of his apparatus of concealment. I have long known the fact that his letters were built up out of significant elements and had been using an ordinary reading glass to help resolve them, but only about four months ago, when it occurred to me to turn a pretty strong microscope upon them, did I discover that nearly all the letters which I had been taking as wholes were really perfect nests of tiny characters."

Now and again, when I was with him in his study, he would ask me what I made out of a group of tiny characters. I took his microscope or his reading glass, and after peering as long as my patience would permit I told him what I saw, or perhaps at his request I copied down on paper the tiny strokes. "Wonderful!" he cried, "I shouldn't have thought you could do so well." But when I asked him what he had made of it, my pride fell: where I had seen eight strokes at most, he had seen twenty-five. He comforted me by saying that he often examined a group of characters for *two hours* before he started to draw what he had seen. No wonder then, that he wrote, in a report of progress to Provost Penniman, on December 14, 1923, that he had been compelled to restrict the amount of time spent on the Voynich Manuscript, on account of the eyestrain involved. But the facsimile drawings given in Chapter

IX, of the microscopic characters forming the Key on the final page of the Voynich Manuscript, give eloquent testimony both to the amount of work which he had done, and to the difficulty of the decipherment.

And as I think of this part of his work, I see him still: half sitting, half lying on his bed, a powerful electric light over him as he examined the text with his reading-glass and his microscope, the latter set in the right side of a pair of spectacles while the left was closed by an opaque disk. Such was his apparatus for study, and I sat at the foot of the bed and listened to the tale of his latest finds. A boyish enthusiasm thrilled him when he read a new word or an unfamiliar syntactical use, and was able to verify it. Did I know the dative with a certain verb? He had read it in the reconstructed text, and had doubted it, but he had found it in Kühner's *Grammar*, and now he actually found it in one of Bacon's writings not in cipher. And that compound word he had asked me about last week, that wasn't in the Dictionaries? He had found that too, quite by accident, as he was hunting something else in the *Opus Tertium*. Did I know the word *parallacs*? It was in the decipherment of the Key, to denote the doubling of the letters: it was the Greek παραλλάξ. And what did I suppose Bacon called the biliteral groups? He had found the term: they were *palanges*, or, with restoration of the *h* which was not written in the shortened alphabet, *phalanges*. He had puzzled a long while over these two passages, for he had had no inkling what the words were, and was quite amazed when he succeeded in reading them.

I read again the "Oxford Story," as Newbold termed it, and a flood of memories almost overwhelms me. Every day or so, while working on it, Newbold told me what he had discovered. In 1273, King Edward had ordered an investigation into crimes and the arrest of malefactors. He had not found this in the histories; he was searching the records of the time. Now he had found something that seemed to point to it; yes, such an investigation had been ordered, certainly, and he had a list of persons who were being held in prison awaiting trial. It was a struggle between nobles and clerics. The serfs were running away from their lords, and taking refuge in the monasteries, leaving the nobles with lands untilled. Of course the nobles tried to get back the serfs, but the serfs were having a better time now, with the hymn-singing and

religious festivals, and the monks did not wish their recruits to be lost. The nobles came with an armed force! Now he had found what the monks did to offset the threatening approach of the nobles: they charged them with schism and with having armed themselves because they realized their guilt. And what had the nobles done? They had sent excuses to the king, or to the king's representatives, for he was still in France, and tried to build up counter-charges. Did I know the meaning of *fucus*? He had never seen the word until he read it in the reconstruction, and when he looked it up in the dictionary he had actually found it, and had found that it had just the meaning demanded by its place in the text, a *pretence* or an *excuse*. The monks had shut up the entrances to the monastery, to keep out the assailants. And here he had the name of Roger Bacon himself; Roger had been placed in charge of the back entrance to the monastery. The knights with their forces had come down to the Thames, opposite the monastery of the Friars Minor, ready to cross for an attack. But why had they not crossed and attacked? The people, belonging to neither side, but disturbed in their usual means of livelihood, had gathered and raised a great uproar, asking the contestants not to trouble the peace further. And the nobles somehow had not dared go further. And what was this—something about the Chancellor—why, they gave him a military salute as a form of apology. But that did not end it: there were others who demanded the same form of apology, and they got it. But meantime Bacon had secretly left the gate where he was in charge, and had gone into the town. For what could he have been seeking? Materials for gunpowder! Not to shoot with, but to scare off the enemy by fireworks, which would make flashes like lightning and noises like thunder, as he says in his other writings. And he pretended that he was going for medicine for the injured—that was a joke on the besiegers. But presently the nobles withdrew their forces, and there was the best joke of all; they claimed that their disorderly conduct had been the result of too free drinking on April first—no wonder they had made fools of themselves. And see the ironic remark with which Bacon ends this extract; successful crimes aren't investigated. He certainly had a sense of humor, did old Roger.

So I find him writing, on March 4, 1920, in words that sound to me as fresh as if just from his lips, "I have been revising my readings

of the characters in the . . . legend, and have reason to think that there are still more, overlooked at first. It is not surprising, for this is the most difficult that I have yet attempted. Each group of letters is carefully hidden by a dense blot, and I could not have made out any of them if I had not thought of studying them by transmitted light, holding the photograph between my microscope and a bright gas-light. This enabled me to see a good many, but I am pretty sure that there are more, which will perhaps add a word or two."

The novel character of the cipher and the difficulty, the almost impossibility, of securing objective proof of its validity made Newbold cautious about hasty publication. In that same letter of February 7, 1920, from which quotation has been made, he said to his correspondent, "I will also ask you to use your discretion in telling anyone else what I have told you in this letter. I speak of the subject freely to my friends, but do not wish to make any public claim until I have evidence to submit which any intelligent man can understand. You see, I have ever before my eyes the Shakespeare-Bacon cipher!"

But his work did gain premature publicity, and much criticism was passed upon his work, some even by persons who confused Roger Bacon with Francis. It was because of this that after the publication of his lecture at the College of Physicians Newbold resolutely refused to allow anything emanating from himself to be printed: he stood firm in anticipation of the day when his studies should appear in complete and finished form. That volume must be replaced by the present one, drawn from his unfinished papers, lacking so much that he would have put in his own. And with this inevitably the question comes, that I must ask of myself, as others too will seek to know, how much of what Newbold claims for his cipher can be considered valid? The problem has been before me constantly during the editing of this volume: for Newbold was either a deliberate impostor, or a self-deceived enthusiast who read into groups of letters what was not there, or a great interpreter of the most difficult cipher ever made by the mind of man.

He was not an impostor. No one who knew him even slightly could doubt his absolute honesty, his scholarly integrity; and for those of us who have known him intimately for many years, such a suggestion seems little short of sacrilege. One may however

fairly deliberate between the other two views. For those who are to study and to pass upon Newbold's claims, I wish to put forward the following summary of facts which may be regarded as objectively demonstrated.

1. The Voynich Manuscript is unquestionably in cipher.

2. The apparent characters of the writing cannot be made into an alphabet, of which each symbol has a definite meaning. For, as Newbold writes, "all attempts to reduce them to a limited number of forms end in bewilderment. . . . each seems to be fluid in structure, tending to shade away in imperceptible degrees into forms of radically different shape . . . to construct an alphabet of such symbols is impossible." And while he said these words specifically of the characters which do not closely resemble Roman letters, he spoke in similar terms of those also.

3. The apparent characters, viewed under the microscope, are seen to be composed of tiny separate strokes, too carefully made to be mere accidents.

4. The tiny strokes must then be the significant elements.

5. The last page of the Voynich Manuscript contains what is a Key and can be nothing else, a fact noted by Newbold as soon as he saw it.

6. With the aid of his alphabets which he derived from the Key, Newbold has read a number of items which were not known to him, and yet have been verifiable from other sources:

(a) The date of the comet of 1273, the doctrine that a comet loosens spirit from matter, that this comet loosened "Margaret's" spirit from matter; see Chapter XII.

(b) The location of the Great Nebula of Andromeda, couched in terms which meant nothing to Newbold, but defined its place in the skies very satisfactorily; see Chapter XI.

(c) The annular eclipse of 1290; see Chapter X.

(d) The political rivalry of Cato the Censor and Fulvius Nobilior; see Chapter XIII.

And in cipher documents of the Latin form, he found verifiable items:

(e) The riots at Oxford in 1273, confirmed in part at least by contemporary records; see Chapter XIV.

(f) The account of the illness of Pope Clement IV and of

remedies which Bacon prescribed, wherein several items were unknown to Newbold, but were verified; see Chapter XVII.

(g) The formula for the production of metallic copper, which proved to operate perfectly; see Chapter XVIII.

(h) The reading of the word *cupa* in the Vatican Document, with all that it involves in the interpretation of the drawings of the Voynich Manuscript, and the reading also in the Vatican Document of Lull's belief in the pre-existence of the soul, quite contrary to what was then known of Lull's teachings, though it was later verified; see Chapter XVI.

There are no doubt other items of more or less weight in Newbold's papers, but I have not been able to find them, or else I have not had the learning to understand them. Yet these eight items, some of them containing several parts, are enough to forbid sweeping condemnation of Newbold's work. A few coincidences may be accepted; but here we have too many, and of too peculiar a character. And again I must quote Newbold's own words as to his arrival at a true value for the symbols: "When I first constructed the biliteral alphabets I gave them values corresponding, as far as possible, with those of the ordinary Latin alphabet. Then I tried to read the Latin cipher texts, but found that they made no sense. Then I tried the experiment of translating these values into those of the conversion and the reversion alphabets. Again, the conversion alphabet made no sense, but the *reversion alphabet gave me at once complete Latin words or fragments of words which could readily be completed from the adjacent latters.*"

The italics are mine; and I must repeat here also what he says of the reconstruction of the disordered text: "The element of doubt introduced by the necessity of recomposing the anagram is not, I think, as great as it might seem to be. When I succeeded in hitting the clue early, the way it comes out is very impressive, to me at least. I keep on constructing new words and carrying over a residuum of unmanageable letters until I get near the end; then I discover that the last group of letters not only makes a word, but just *the* word needed to complete the sense."

Newbold was withal a most modest scholar. He never felt the slightest jealousy of another who might have anticipated his own results, or who might somehow have been preferred to him. He

did not have an exalted idea of his own achievements. I look through his papers and I find him saying, "This looks promising, but it falls short of the absolute demonstration which I wish to have before making any definite claim" . . . "The first three words are quite clear, but the last two are uncertain" . . . "Of course I often make mistakes in reading the cipher characters and have endless trouble correcting them" . . . "My translations were made from poor photographs and undoubtedly contain many errors." . . . "I have no doubt that in all these texts there are many mistakes, and much time must be devoted to their correction before they will be in proper shape for publication."

But along with his modesty Newbold had a certain confidence born of the verifiable results which he had secured; and he was absolutely confident that despite errors of detail in his work, his system was fundamentally correct and his decipherment of the cipher of Roger Bacon was in its main lines valid beyond shadow of doubt. And when one reads the words which I have just quoted he should not look upon Newbold as in any way impugning his own work; he should rather regard them as utterances of the true scholar, ever ready to receive the corrections of others and to use them gratefully.

Most of those utterances indeed date from the early years of his work upon the Voynich Manuscript; but so do many of the papers used in preparing the Chapters of this volume. I am sure that he would not have used everything that I have included; much less would he have included them without revision, as I have perforce done. The serious critic of Newbold's work will bear this in mind, noting that this is but an imperfect representation, an attempt to place within the reach of others the means of continuing the decipherment, if others there be who can and will essay it. To them I would say that while I have corrected errors where I could, I have allowed other errors to stand but have called attention to them in notes, deeming changes dangerous where so many times I had found an apparent error on Newbold's part to be but in my own imperfect understanding of the point.

I have already quoted Newbold's own words to show that he did not wish to make any public announcement until he had got his materials into a good and convincing form. It was not until April 20, 1921, that he felt able to put them definitely on record. On the

evening of that day he delivered his lecture on "The Voynich Roger Bacon Manuscript" at the College of Physicians of Philadelphia; and on the afternoon of the following day, he spoke before the American Philosophical Society on the nature of the cipher. Other lectures which he delivered in Philadelphia and elsewhere dealt with the same subjects. But until the present publication, the only printed accounts of his discoveries that may be considered as authoritative, because written or revised by him himself, are those contained in the printed form of the lecture at the College of Physicians, which formed pages 431–474 of their *Transactions 1921*; and a short account of my own, in *The Pennsylvania Gazette* for May 27, 1921, written at the request of the editor of that journal to provide an accurate account to the alumni of the University of Pennsylvania and thereby to counteract many wild statements that had appeared in newspapers and periodicals. Any other accounts are based on these two, or on the addresses made by Newbold, or on materials privately furnished, or on actual conversations with him. The insufficiency of such sources for scholarly critique of his views, is hardly to be disguised. The present volume is intended to fill the gap, so far as the materials left by Newbold suffice for that purpose.

But Newbold, as I have said, was interested in so many things that he was easily distracted from the task in hand. He was of such an inquiring mind that when he had solved a problem to his own satisfaction he had little interest in the labor of putting his discoveries into form for printing, a labor of much greater irksomeness than all his toil in pursuit of the unknown, when he was stimulated by the prospect of discovery. His courses of lectures at the General Theological Seminary in New York, his study of the Great Chalice of Antioch, and that of the Aramaic inscriptions in Latin letters, all kept him from his promised volume on Roger Bacon. On December 14, 1923, in response to an inquiry from Provost Penniman as to his progress, he wrote the following:

"Most of my time for the last two and a half years has been devoted to the Latin form of the cipher, chiefly because of the discovery of two new documents written in that form of the cipher, both of very great importance. But also I have been compelled to restrict the amount of time spent on the Voynich Manuscript on account of the eyestrain involved. Indeed little more can be done with the microscopic characters until the manuscript has been

photographed by experts, and laboratory facilities provided for the relief of the strain on the eyes involved in trying to read with a single lens. Moreover the difficulty of deciphering the tiny characters is such that mistakes are inevitable, and since the results of such mistakes are cumulative, continuous reading is not at present possible. I have not attempted to do more than read short legends."

He then spoke of facts which he had read that were unknown to him at the time, but were later verified from other sources; these are given in Chapters XII, XVI, XVII, and XVIII. He concludes his letter as follows: "I regret the delay in publishing this material, but it cannot be helped. Progress is slow, for the labor involved is very great. The second point, for example, as to the cause of Pope Clement's death, necessitated a search through about two hundred folio volumes of Chronicles and the reading of about six hundred of the Pope's Latin letters. Before I could read the Vatican document I had to master Lull's very difficult system, and that involved learning Catalan and reading about one thousand pages in that language, of which I knew nothing, not to speak of as many more in Latin. I hope however to have it ready by the end of next summer."

The end of next summer! That would have been in the year 1924. When Newbold returned from his summer home in Maine, in September, 1926, he brought with him two finished Chapters, numbered III and IV, which appear in this volume as IV and VI, and a series of Tables of Values, which form a good part of Chapter XX. He was full of enthusiasm for the finishing of the task; he had never been a man of vigorous physique, but had not for years felt so invigorated and strengthened by his summer's rest. Ten days later, he was stricken with a sudden illness, and in less than twenty-four hours he lay dead.

The materials which were available for the preparation of this volume are the following:

1. The printed lecture at the College of Physicians, *Transactions 1921*, 431–74; this forms Chapters I and III, and part of XI.
2. Mr. Voynich's account of the history of the manuscript, in the same *Transactions of the College of Physicians 1921*, 415–30; now Chapter II.

3. The typewritten copy of the present Chapters IV and VI, and of part of Chapter XX.
4. The manuscript copy of Chapter V, an apparently rejected draft to be replaced by what is now Chapter VI.
5. A number of typewritten charts which had been photographed for distribution to interested friends and for the making of lantern slides; these cover parts of Chapters VIII and XVI especially.
6. The letter to Provost Penniman, dated December 14, 1923; this has been used in Chapters XII, XVI, XVII, and XVIII.
7. Notebooks containing deciphered texts and other materials.
8. Photographs and photostats of manuscripts.
9. Hundreds of loose sheets and miscellaneous papers.

At the beginning of each Chapter I have in a note stated the materials from which the Chapter was drawn. I have tried throughout to let Newbold tell his own story; the first person pronoun is always Newbold, and never another, except in this introduction, and of course in verbatim quotations. Whatever I have myself written, even when it is made to appear as Newbold's own words, is enclosed within square brackets. If I have had occasion to express a critique which could not in the nature of things have proceeded from Newbold himself, I have placed it in the footnotes, and have added my own initials at the end; otherwise even the parts which I have written and have put in brackets might have been Newbold's own words; indeed, they are often mere paraphrases of what he has said elsewhere in his writing.

But there have been none too infrequent points at which I have had to intrude some comments of my own. For the materials included papers of a very early date. Often there were several versions of the same thing, perhaps only one reasonably finished; sometimes two finished versions, differing in some small points, both undated and giving no clue as to what was Newbold's final view. There were errors of various sorts which I could not eliminate without enormous toil, trifles singly and yet beyond my power to handle; many of these rested doubtless on the date at which the work was done, before he had reached final values for the symbols. Oftentimes I thought that I had found an error, only after hours of struggle to find that the fault lay in me, that I did not understand

the procedure involved; and so in many instances I have preferred to leave apparent errors and to call attention to them in the notes, hoping that others with a better grasp of the subject may see clear where my vision is but dim.

In one duty of an editor I have certainly failed. I have not been able to verify the references, except in part; for many of them are to works which are not accessible to me. The writings of Bacon were prodigious; he wrote and rewrote on the same materials under different titles. Certain of these writings exist only in manuscript; others exist in several widely differing recensions of which only one has been printed; still others are printed only in editions of great rarity. In such cases I have depended upon Newbold's data as correct; and this has been true notably also in the references to the works of Ramon Lull, in Chapter XVI. It will not be out of place perhaps, to list those writings of Roger Bacon to which reference is made in the present volume, with a note as to where they are published. The first item in the list contains the most nearly complete bibliography of manuscripts and editions, compiled by the editor of the volume, Mr. A. G. Little:

A. G. Little, *Roger Bacon Essays contributed by various writers on the occasion of the commemoration of the seventh centenary of his birth*, collected and edited by A. G. Little, Oxford, 1924; bibliography of manuscripts and editions, pp. 375–419.

Opus Majus, Parts I–VII, edited by J. H. Bridges, vols. I and II, Oxford, 1897; with a supplementary vol. III, London, 1900.

Fr. Rogeri Bacon, Opera Quaedam Hactenus Inedita, edited by J. S. Brewer, London, 1859 (Rolls Series); containing the *Opus Tertium* (pp. 3–310), the *Opus Minus* (pp. 313–389), the *Compendium Studii Philosophiae* (pp. 393–519), and the *De Secretis Operibus Artis et Naturae, et de Nullitate Magiae* (pp. 523–551).

Pierre Duhem, *Un Fragment Inédit de l'Opus Tertium de Roger Bacon, précédé d'une étude sur ce fragment*, Quaracchi, 1909.

A. G. Little, *Part of the Opus Tertium of Roger Bacon*, Aberdeen, 1912 (British Society of Franciscan Studies, vol. IV).

F. A. Gasquet, *An Unpublished Fragment of a Work by Roger Bacon*, in the *English Historical Review*, XII 494–517 (July, 1897).

Sanioris Medicinae Magistri D. Rogeri Baconis Angli de Arte Chimiae scripta, cui accesserunt opuscula alia eiusdem Authoris, Frankfurt, 1603; containing *Verbum Abbreviatum de Leone Viridi* (pp. 264–285), *Secretum*

Secretorum Naturae de Laude Lapidis Philosophorum (pp. 285–291), *Tractatus Trium Verborum* (pp. 292–387).

Opera hactenus inedita Rogeri Baconi, edited by Robert Steele; Oxford. Parts 2–4 (the second undated, the others 1911 and 1913) contain the *Communia Naturalium*.

Perspectiva, printed by Combach, Frankfurt, 1614; it forms also the fifth part of the *Opus Majus* (vol. II, pp. 1–166, in Bridges's edition).

The Greek Grammar of Roger Bacon and a Fragment of his Hebrew Grammar, edited by Edmond Nolan and S. A. Hirsch, Cambridge, 1902.

Other writings of Bacon are adequately identified in the notes when they are referred to in the text.

Grateful acknowledgment of courtesies is due to Mr. Wilfrid M. Voynich, for permission to use numerous representations from the manuscript which is in his possession, and to use his account of the history of the manuscript; to the College of Physicians of Philadelphia, for permission to reprint with changes the articles by Professor Newbold and by Mr. Voynich, which were printed in its *Transactions 1921*; to the American Philosophical Society, for permission to use the unpublished text of a paper read before it by Professor Newbold in 1921; to Monsieur Auguste Pelzer, Scriptor of the Vatican Library, for permission to publish Vatican manuscript Lat. 3102; to the authorities of the British Museum, for permission to reproduce parts of pages from their manuscripts Sloane 1754 and 2176; to the authorities of the Bodleian Library, for permission to reproduce and publish two pages of their manuscript Digby 119; to Robert Steele, Esq., Savage Club, London, for permission to publish a decipherment of a Bacon manuscript which he discovered in the Bibliothèque Nationale at Paris; to Professor James Westfall Thompson, of the University of Chicago, for permission to embody the unpublished results of his researches into the history of the Bacon manuscripts; to my colleagues Dean Robert Belle Burke, Professor Hiram S. Lukens, Professor Isaac Husik, Professor James Alan Montgomery, and numerous others, who have helped me on specific points: but especially to Mr. Voynich, who has responded to every call for assistance, whether for information, or for photographs, or for permission to publish information and photographs.

Perhaps I may be permitted to say a few words of my own on the Voynich Manuscript: part, but not all, I get from Newbold.—The composition of the manuscript was a gigantic task; if the few lines of the Key may be considered a fair sample, one line of apparent text yields not far from seventy-five words of deciphered text. A page of text alone, without drawings, may contain as many as forty lines; it may be estimated at about three thousand words of true text. This is conservative, as many pages are made of lines which obviously contain more writing than the lines of the Key. If the use of drawings be calculated to reduce the amount of writing by one half, the original 262 pages, or rather 116 folios with enough pages of extra size to bring the total to the equivalent of 262 pages, must have contained about 300,000 words.

This cannot have been the fourth treatise which Bacon sent to Pope Clement IV in 1267. The other three treatises are identified and are extant; the fourth was in cipher: and yet it cannot have been the Voynich Manuscript. Prodigious worker as Bacon was —he composed the *Opus Majus*, the *Opus Minus*, and the *Opus Tertium* in one short year, after six months of preparation; and the *Opus Majus* alone is said to contain 350,000 words—he could not have enciphered the Voynich Manuscript, at least 300,000 words, in the same year in which he wrote the other three treatises. The possibility still exists, of course, that the lost fourth treatise was a portion of the Voynich Manuscript, that it was sent back or brought back to him, and that he amplified it later. But Newbold reads in it at least two events of later date, the comet of 1273 and the eclipse of 1290. This should be enough, in any event, to make one chary of identifying the Voynich Manuscript with any work written before his imprisonment. There is more likelihood that the fourth treatise has been rediscovered in the Paris Medical Text, which is discussed in Chapters XVII and XVIII of this volume.

So I should like to think of the Voynich Manuscript as its author's work while he was imprisoned: his revenge on his superiors who forbade him to pursue his researches into the mysteries of science. What would be more natural? Here was the greatest scientist of his age, forbidden to continue his work and his writing, held in a limited imprisonment. In the time that was left to him from such tasks as were imposed upon him, he inscribed in an inscrutable

cipher all those discoveries which he believed to contain potential blessings for his fellowmen. What they would not have, he would none the less record for all time, and in such a way that no man, barring perhaps his pupil John and one or two others whom he had trained, might with prospect of success endeavor to decipher. In the twenty-odd years of his imprisonment, he labored at this manuscript: was he embittered at his persecutors, or did he smile genially to himself as he thought of their futility, knowing as he did that some day the truth would out, though he might never have credit for his discoveries? I fear it was rather in a bitter spirit, and with a stern grimness that he stole for his work such hours as he had at his disposal, hiding jealously from prying eyes the precious pages as he finished them; one page a month for twenty years would have brought his task nearly to its end, and two more years lacking two months would have seen its completion. This is mere speculation on my part; yet may we not indulge in speculation when no facts exist to hold us in restraint?—And did his superiors know of the writing which he was doing? Perhaps he had the craft to hide it from them, and to smuggle the volume away into the hands of John. Or perhaps they knew of it, and thought poor Roger daft, making little letters and drawings which had no meaning. Roger may even have fostered such a delusion on their part, to guard against accusation of witchcraft.—But again, this is all fancy. I would not have you think I take this from Newbold. No such suggestion did he ever make to me, though he did believe that the Voynich Manuscript was the work of the years of imprisonment, when Roger could pursue no further researches, and thrown back upon what he had done already in experimental science could but devote himself to the recording of his observations.

Why, after all, should I, who claim comparative philology for my special field, have been the one to edit and complete these more or less *disjecta membra* of a study in Bacon, in philosophy, theology, astronomy, in mediaeval Latin, in ciphers? All these things lie outside my field. I can but claim to have been the friend to whom Newbold told his discoveries as he made them, who rejoiced with him as he unfolded his tale, who tried to understand the intricate system that was involved. Many an hour we spent together, and of all to whom he talked—and he talked gladly to those who were

interested—I was the one who heard him oftenest and longest. That is why I have been asked to perform the task, and that is why I have accepted it. I have tried to let him tell his tale in his own words, and have sought to explain where his words might lack clarity. I have tried to present his material in a sympathetic and yet a critical spirit: I have not hesitated to call attention to his errors, or seeming errors; but I have kept before the reader, I trust, the work of the true author, with the sympathy born of long and intimate association.

And as I close this foreword, Will Newbold seems very close at hand. I see him again at work, peering through his magnifying spectacles that lie before me as I write. When I have ended this page and my task is done, I fear his spirit may never again seem so near. *Frater, ave atque vale.*

R. G. K.

Philadelphia
August 11, 1927

CHAPTER I

The Forerunner of Modern Science

Throughout the dark and turbulent stream of human history[1] there runs a series, often obscured or interrupted but always recurring, of wholly beneficent discoveries, marking the successive steps in man's acquisition of control over the powers of nature. Some primitive creature first grasped a stone as a weapon, and thus made man a tool-using animal; another wielded a stick, discovering the principle of the lever; another chipped his stone, and introduced the cutting edge; another learned to smelt copper, and the age of metals dawned. Of these benefactors of the human race, few even of later times are known by name, and they receive but scanty honor. Not many statues are erected to their memories, and seldom does anyone think of them with gratitude.

Still more seldom does anyone think of those men of genius, and there must have been many of them, who lived and labored for the advancement of knowledge, yet died in the bitter consciousness of failure. Some were intellectually unequal to the task they had set themselves; some saw their efforts frustrated by untoward circumstances; some succeeded in their efforts, but only to find themselves overwhelmed by incredulity, obloquy, even persecution. One such genius, whom his contemporaries could neither understand nor appreciate, is soon, I hope, to be accorded the honor which is his due.

Of all inventions, few if any have contributed more to the increase of knowledge than those of the microscope and the telescope. The telescope has extended the range of vision far out into the depths of space; the microscope has revealed the existence of the unimagined realm of the infinitely little, and often exposes to view the secret mechanism by which the processes of nature are accomplished.

[1] [On April 20, 1921, Newbold delivered a public lecture on *The Voynich Roger Bacon Manuscript*, being the Fifth Lecture on the Mary Scott Newbold Foundation, at the College of Physicians of Philadelphia. This lecture was printed in the *Transactions of the College of Physicians of Philadelphia, 1921*, pages 431–474. The first part of this lecture, here reprinted by special permission, forms the present Chapter.—RGK]

That both of these indispensable instruments were known to and probably discovered by Roger Bacon, and that by their means he made discoveries of the utmost importance, the Voynich Manuscript puts beyond the range of reasonable doubt.

Born near the beginning of the thirteenth century, Roger Bacon lived almost to its end He was a contemporary of that eccentric genius Emperor Frederick II; of Henry III, King of England, in whose unworthy cause Bacon's brothers fought and were impoverished; of his son, Edward III, "the English Justinian," who laid the foundations of the present system of English law and crystallized into being the English Parliament, ancestress of all the democratic governments of the present day. Bacon's life was passed at Oxford and Paris, the centers of the intellectual life of the age, and thus he became personally acquainted with its leaders—among them, to mention a few out of many, with Robert Grosseteste, scholar, statesman, Bishop of Lincoln; with Saint Bonaventura, the devout and mystical theologian, head of the Franciscan Order of which Bacon was a member; and in particular with Albertus Magnus, and probably with Thomas Aquinas. These two, the most renowned of the scholastic philosophers, were even then engaged in assembling the whole of knowledge, especially as recorded in the encyclopedic works of Aristotle, in order to show its harmony with the doctrines of the Catholic Church, and the system of philosophy which they built up is to this day, I believe, taught in every Catholic institution of learning.

In that age Bacon lived, but he was not of it. He belonged rather to our own time. The knowledge amassed with such toil by his contemporaries he contemptuously casts aside as little better than rubbish;[2] it is founded, he holds, in the main upon reverence for authority, and reverence for authority but too often leads to little more than repetition of ancient errors. There is but one ultimate test of knowledge, experience, and but one way of organizing such knowledge into a science, namely, by showing its conformity to the laws of mathematics.[3]

Thus Bacon lays down with an assurance which, in view of the embryonic condition of the physical sciences known to him, one

[2] *Opus Minus*, 325–30; *Opus Tertium*, 30–31; *Opus Majus*, I 2–4. [For a list of accessible editions of the writings of Roger Bacon, see the Foreword.—RGK]

[3] *Opus Majus*, I 97 ff.

can but compare to the intuition of a supreme genius, the fundamental principle of mathematical physics. Only less amazing are his bold applications of common-sense principles in the fields of textual criticism and of education, especially as regards the necessity of knowing the original languages of works usually read in translations, his appreciation of the need of endowing research work, his forecasts of the development of medicine in the direction of hygiene and preventive medicine, of the applications of chemistry to physiology, medicine, agriculture, and industry, and his visions of the contributions to human comfort which applied science ultimately was to make by producing a multitude of useful inventions.

Many of his theories, supposed facts, and forecasts were of course mistaken—how could they not be, in view of the poverty of the intellectual nourishment with which he had to feed his genius? The universities of Oxford and Paris were almost wholly given over to theology and the Aristotelian science and philosophy. Bacon mastered all that was then known of Aristotle, but Aristotle's method, for reasons which I shall presently explain, was of little assistance to him. At Oxford, Grosseteste, himself a scientific genius of no mean order, implanted in Bacon's mind many of the principles which were later regarded as original with his pupil, and also first introduced him to the languages and to the study of the non-Aristotelian science. Bacon learned Greek, and diligently sought out the existing remains of Greek and Roman science, and of the Arabic science which had been inspired by it and had recently been translated into Latin. Thus he learned the Greek arithmetic, the Hindu-Arabic system of notation and calculation, the Greek and Arabic optics, astronomy, astrology, alchemy, and medicine. He acquired considerable knowledge of Hebrew and Aramaic, and probably a little of Arabic. He even learned something of that strange Gnostic philosophy, the Kabbalah, which, after being handed down among the Jews by secret channels for a thousand years, was in Bacon's own lifetime being compiled into the *Zohar*.

In all these sources he found theories aplenty, but comparatively little of that empirical knowledge for which his soul hungered. So he sought it elsewhere. As Aristotle had done before him, he inquired among the artisans, farmers, old-wives, and other such simple folk. Each of them, however ignorant, knew something

which the most learned scholars did not know. "From them," says Bacon, "I learned more and beyond all comparison more important things than from all my learned doctors."[4]

Still unsatisfied, he ventured yet further from the beaten track, into fields in which no son of the Church could roam save at his peril. He studied the magic properties of herbs, the virtues of charms and incantations and the like, seeking out in all the forbidden books the secrets of Greek and Roman, Jewish and Arabic, magic and necromancy.

When writing to Pope Clement, in 1267, Bacon drew a sketch of the ideal scientist, ostensibly the portrait of an unnamed friend. The context indicates that Peter of Maharncuria was the friend in question; but one can scarcely doubt that, as he was drawing it for the Pope to contemplate and to admire, he must have hoped that the Holy Father would realize there was another man besides Peter who might have sat for that portrait. And as every line of the sketch can be shown to portray faithfully Bacon's own features, I need make no apology for quoting it in full. Bacon has been speaking of optics, and proceeds:[5]

I know of no man save one who deserves credit for his work in this science. In lectures and wordy battles he has no interest, but pursues his scientific work and in it finds contentment. So it is that all which other men are blindly trying to see, like bats in the twilight blinded by the setting sun, he contemplates in the full glare of day, because he is a master of experiment. Therefore by experiment he acquires knowledge of the products of Nature, of the things studied by medicine and alchemy, of all things indeed whether in heaven or on earth. He is in fact ashamed that any layman or old crone or soldier or rustic fresh from the country should know anything which he does not himself know. Hence he has peered into all the processes of smelters, of goldsmiths, of silversmiths, and of other workers in metals and minerals; he knows everything pertaining to war, weapons, and hunting; he has examined everything pertaining to agriculture, surveying, and other occupations of the countryman; he has even taken into consideration the experiments of witches and their fortune-telling and charms and those of magicians in general, likewise the tricks and illusions of legerdemain—so that nothing worth knowing might remain unknown to him and that he might know what to condemn as due to sorcery or magic. Hence without his aid philosophy cannot be perfected, nor can it be pursued with any good or trustworthy results. Moreover, as he is beyond price, so also does he put no price upon himself. If he wished to meet kings or princes on terms of equality he would easily find one to honor and enrich him; indeed, if he were willing to exhibit at the

[4] *Opus Majus*, I 23.

[5] *Opus Tertium*, pp. 46–47.

University of Paris what he has learned by his scientific work, the whole world would follow him. But because either of these courses would interfere with the splendid experiments which give him the highest pleasure, he disregards all honor and riches, the more willingly because he can acquire wealth by his science whensoever he will.

In the Gasquet *Fragment*[6] Bacon gives a vivid picture of the difficulties with which a scientific investigator of the thirteenth century had to contend. After speaking of the dishonesty and untrustworthiness of most professional copyists, he proceeds:

And inasmuch as besides copyists other persons are required who will keep watch on their dishonesty and negligence, who will not only correct the copies but are also expert in computations, calculations, and languages (for without these three nothing of moment can be accomplished, as will be made manifest from the books which I am sending your Glory), there is more labor in scientific work than any one unacquainted therewith could imagine. Furthermore, without astronomical, geometrical, and optical instruments, and those of many other sciences, nothing can be accomplished, for through these we acquire knowledge of many celestial objects and from them the causes of the things beneath them. But effects cannot be known without their causes, therefore without such instruments nothing of great moment can be known. One ought then to have them, and yet few of them have been manufactured among the Latin-using peoples. Also a plentiful supply of books is needed relating to all the sciences, historical records (*actorum*) as well as the works of learned men of old, and they are not to be found either in my possession or in that of any one else; one has to collect them from the libraries of scientific men in various countries. Furthermore, since authors contradict one another on many points and have made many assertions on merely hearsay evidence, it is necessary to ascertain the truth by experience of actual facts, as I prove in my treatise on the experimental sciences. For this reason I have very frequently sent beyond the sea and to various other countries and to the regular fairs that I might see the objects of Nature themselves with my eyes and test the reality of the created thing by sight, touch, smell, and sometimes by hearing, and by the certitude of experience, in cases in which the truth was not made self-evident to me by books, just as Aristotle sent many thousand men through various countries in order to learn the facts about things.

The general nature and range of Bacon's scientific work may be gathered from various passages in the books addressed to Pope Clement IV in 1267. He had been a hard student ever since he learned his letters, a period of about forty years, except that two of those years were devoted to the recovery of lost health. About twenty years were devoted especially to the study of science, and ten of the twenty to optics. During these twenty years he had

[6] *An Unpublished Fragment of a Work by Roger Bacon*, discovered and published by Cardinal Gasquet, *English Historical Review*, July, 1897, p. 501.

spent on "secret" books, experiments, languages, instruments, astronomical tables, in forming friendships with scientists, in teaching his assistants the languages and the use of figures, tables, instruments, and the like, more than two thousand pounds, which, even if taken only as Parisian pounds, would be equivalent in purchasing power to about fifty thousand dollars of our money, an average of two thousand five hundred dollars a year.[7]

The precise date of Bacon's entrance into the Franciscan Order is not known, but comparison of his various allusions to his past life indicates 1256 or 1257 as the most probable year. During the ten years preceding 1267 ill-health had made him an exile from the public lectures and debates of the University of Paris, in which he had formerly won no little reputation, and that same lack of health, combined with lack of money, isolation from his friends and collaborators, and the insistence of his superiors that he devote himself to other occupations, had compelled him not only to forego the composition of scientific works but also to leave incomplete and unused the "many useful and grand wonders of science" which he had brought together at great cost of time and money, partly from books and partly as the results of his own experimental work.[8]

It is obvious that the greater part of the twenty years of work must have preceded, and the ten years of comparative idleness have followed, Bacon's entrance into the Order; the remaining ten years of the forty that have elapsed since his childhood were, presumably, those of his early education.

The motives which prompted Bacon, when forty years or more of age, to enter the Franciscan Order are entirely unknown, and I

[7] *Opus Tertium*, pp. 7, 38, 59, 65; Gasquet *Fragment*, pp. 500, 507. Purchasing power calculated from the data given by Sir. J. H. Ramsay, *Dawn of the Constitution*, 1908, pp. 300 ff.

[8] *Opus Tertium*, p. 7: . . . recolens me iam a decem annis exulantem quantum ad famam studii quam retroactis temporibus obtinui . . . Gasquet *Fragment*, p. 500: Insuper quia iam a decem annis propter languores multos et infirmitates varias occupationibus exterioribus studii non vacavi . . . Multa vero alia fuerunt impedimenta componendi, scilicet langor continuus, defectus expensarum, adiutorum inopia. Nullus enim per se sufficit in rebus eximiis. Affuit enim instantia prelatorum meorum cotidiana ut aliis occupationibus obedirem et ideo non potui aggredi que volebam: immo aggregatis impedimentis incepi desperare, et multa utilia et magnifica sapientie spectacula, que variis expensis ac scripturis et laboribus multis et tempore longo collegeram, neglexi antequam primum vestre dominationis recepi mandatum.

shall not venture to speculate upon their character. Whatever they were, the step must have proved highly detrimental to his scientific work. Undoubtedly his interest and belief in alchemy, astrology, and magic, must have brought him under grave suspicion of heresy, and his superiors could not have been disposed to encourage him in them. It is not probable that they absolutely forbade them, but they refused him the authorization without which no Franciscan brother could write for publication, and they kept him, as above related, so busily occupied with uncongenial tasks, among which begging food for the support of the monastery at Paris was probably not the least uncongenial, that he had little time or energy for anything else. Bacon's frequent allusions make it abundantly evident how these restrictions galled his proud spirit, and one can imagine how eagerly he would have looked for some way of deliverance.

In the year 1265 a ray of hope dawned upon him. Guy de Foulques, or Guido Fulcodi, who had been Archbishop of Narbonne before his elevation to the Cardinalate, was in that year elected to the chair of St. Peter and assumed the name Clement IV. He was a man of superior ability, of pure life, high ideals, and determined will, had had a distinguished career as a soldier and statesman before his entrance into the Church, and had known of Bacon and displayed interest in his work before his election as Pope. Elated at the possibility of finding so powerful a protector, Bacon wrote him a letter, sent it by a friend, Sir William Bonecor, and authorized him to explain more at length to the Pope his purpose in writing it. That letter has been lost, but from the Pope's reply[9] one may infer that in it Bacon spoke of his work and also offered the Pope certain remedies in connection with a crisis of some sort. The reply was written in June of 1266; the Pope asks Bacon to send the works which he understands Bacon had written and also to inform him as secretly as possible what the remedies in question were.

The despised and oppressed scholar was transported with joy. After only six months of preparation he wrote in one short year, notwithstanding the all-but-insuperable difficulties interposed by his poverty and by the opposition of his superiors, the three bulky works upon which his fame has hitherto mainly rested, the *Opus*

[9] *Op. Ined.* p. 1.

Majus, the *Opus Minus*, and the *Opus Tertium*. With them he sent a fourth, which is supposed to be lost.

The purpose revealed in these works is one of sublime audacity. The obscure and oppressed friar, fully conscious, as he himself says, of his insignificance, of his manifold ignorance, of his tongueless mouth and scratchy pen, silenced, buried, erased in oblivion, endeavors in all earnestness to convert to his own point of view the Head of the Church, the Vicar of the Saviour, the Lord of the entire universe! To appreciate Bacon's daring, one needs a clear comprehension of the irreconcilable antagonism between the principles which he advocated and those that governed the age in which he lived.

I have said that the characteristics of Bacon's mind which made him alien to his own age and spiritually akin to ours are in particular his attitude towards authority and his appreciation of the importance of empirical evidence. Sweeping generalizations are often only partly true, but none the less they are indispensable if one is to express salient facts in brief, and I think that, if that qualification be borne in mind, the statement will not be found misleading.

In all ages the conduct of the mass of men is largely influenced by recognition of the authority of other men, but the extent to which authority is exercised, the individuals who are recognized as possessing it, and the reasons by which its recognition is justified, vary from age to age. In the thirteenth century European society was organized upon a feudal basis. Theoretically, supreme authority was conferred by God upon the King, by him upon the high nobility, and from them derived to the lower social orders. Every man was the "man" of some "lord"; his chief duty to society was that of obedience, within the prescribed limits, to his lord; the "lordless" man was an outlaw. The Church was organized upon similar principles, in a hierarchy comprising Pope, Cardinals, Bishops, Priests, Deacons, and "Religious." The habit of mind corresponding to this type of organization was reflected in the world of thought. The Church was accorded supreme authority in matters of belief. The truths it sanctioned were expressed not only in the Bible and in the decrees of Popes and of Councils, but also in the writings of the Fathers approved by the Church as "authorities," whose utterances might be quoted to prove or disprove any allegation of fact. In addition to the Fathers, certain secular and even non-

Christian "authorities" were slowly winning recognition. Aristotle had but recently been accorded that rank, an influential group was striving for the recognition of Averroes and other Arabian philosophers, and Bacon complains that his own contemporaries, Alexander of Hales and Albertus Magnus, are already quoted as "authorities" in the University of Paris.

The only scientific method recognized by the Universities was essentially the method of Aristotle. Aristotle had taught that "science" in the proper sense is a body of necessary and eternal truths, consisting exclusively of certain self-evident principles together with the inferences which may be derived from them by syllogistic reasoning. Sense-experience is of importance as a means of access to the self-evident principles, but is of no independent authority whatsoever. Aristotle also recognizes the propriety of using in syllogistic reasoning, under certain circumstances and for certain defined ends, principles based upon authority, which he terms *τὰ δοκοῦντα*, and the method which employs them he terms "dialectic." But he expressly excludes from the scope of "science" both the principles and the conclusions deduced from them. The mediaeval Aristotelians, however, placed the authorities above mentioned on a level with intuitional truths as primary sources of knowledge, and sometimes sought to justify this modification in Aristotle's scheme upon Aristotelian or Platonic principles. But to sense-experience they conceded little more importance than Aristotle had done.

This overemphasis upon the deductive method is the fatal defect in the Aristotelian theory of science. It is an excellent instrument for the classification of existing knowledge, but if not supplemented by experiment it will seldom lead to the acquisition of new knowledge. Wheresoever it has prevailed science has remained stationary, stagnant. And this is precisely the point in Aristotle's system against which Bacon directs his most telling blows. He by no means rejects the deductive method; he acknowledges its importance and employs it himself. But he does deny its adequacy, and he *places experience above it*. Experience is not merely a means of reaching intuitive principles; it is itself a source of certitude superior to that of intuition; it is indeed the *only* source of certitude; conclusions deduced from intuitional principles, even those of mathematics (!), must be verified by experience before they can be

really believed. It is also the only instrument for the discovery of new truths, whether they do or do not ostensibly lie within the spheres of recognized sciences.[10]

The principle of authority Bacon criticizes with equal severity. He accepts formally, and I think sincerely, the authority of the Church and the Bible, but rejects in principle that of the Fathers and the philosophers. He does not, of course, deny that in practice the individual scholar must rely to a large extent upon the opinions of his competent predecessors in forming his own. He had indeed, himself, no little respect for the Fathers and for Aristotle and is reluctant to differ from them, but he denies absolutely that their judgments are final. By numerous quotations he proves that even the greatest of the recognized authorities, such as Jerome and Augustine, repeatedly contradict both themselves and one another, and he does not shrink from the obvious conclusion that they are but fallible men. The principles laid down by such authorities must be tested by experience before they can be finally accepted.[11]

The "experience" which Bacon thus recognizes as a third criterion

[10] *Opus Majus*, II, p. 167: . . . sine experientia nihil sufficienter scire potest. Duo enim sunt modi cognoscendi, scilicet per argumentum et experimentum. Argumentum concludit et facit nos concedere conclusionem, sed non certificat neque removet dubitationem ut quiescat animus in intuitu veritatis, nisi eam inveniat via experientiæ . . . p. 168: Et hoc patet in mathematicis, ubi est potissima demonstratio. Qui vero habet demonstrationem potissimam de triangulo æquilatero sine experientia nunquam adhærebit animus conclusioni. . . . p. 202: . . . veritates magnificas in terminis aliarum scientiarum, in quas per nullam viam possunt illæ scientiæ, hæc sola scientiarum domina speculativarum potest dare. . . p. 215: Et . . . ex propriis per quæ non habet respectum ad alias scientias, sed sua potestate investigat secreta naturæ. . . p. 221: tota sapientiæ speculativæ potestas isti scientiæ specialiter attribuitur.

[11] *Opus Majus*, III, p. 3: Nulla loquor ratione de solida et vera auctoritate, quæ vel Dei judicio collata est Ecclesiæ, vel quæ ex merito et dignitate personæ nascitur in sanctis et perfectis philosophis et aliis sapientibus . . . III, p. 6: Quod per auctoritates probatum est experientia cujuslibet certius dijudicat. . . . p. 13: Manifestum est quod mens humana non sufficit dare quod necessarium est in omnibus, nec potest in singulis vitare falsum nec malum. . . . p. 15: Sed non solum philosophi immo sancti aliquid humanum in hac parte sunt passi. Nam ipsimet retractraverunt dictorum suorum quamplurima. . . . Sancti etiam ipsi mutuo suas correxerunt positiones et sibi invicem fortiter resistebant. . . . III, p. 16: Quoniam igitur hæc ita se habent non oportet nos adhærere omnibus quæ audivimus et legimus, sed examinare debemus districtissime sententias majorum, ut addamus quæ eis defuerunt, et corrigamus quæ errata sunt, cum omni tamen modestia et excusatione.

of truth, in addition to the authority of the Church and the Bible, occurs in two forms, sensuous and spiritual. Sense-experience, which he often calls "experiment," includes both observation, and experiment in the narrower sense. That Bacon was aware of the importance of the experimental method is shown by his actual use of it, but it does not appear that he had ever attempted to define it and to distinguish it from mere observation.

By "spiritual experience," Bacon meant, in particular, that intuitional apprehension of spiritual truth which God accords by special revelation to certain individuals. His recognition of it is designed not merely to provide a place in his empirical scheme for his other two criteria, but also for the special revelations claimed by men of later ages. It is not unlikely that he had Abbot Joachim in mind, for whose claims, as it would seem, Bacon had no little sympathy. But he also included in "spiritual experience" that immediate intuition of generalizations which Aristotle had ascribed to the "poietic" or "operating" Reason, but which Bacon believed to be the immediate operation of the Divine Intellect in the depths of the purified human intelligence.[12]

Bacon not only appeals to the Pope to accept his new principles as intrinsically sound, but also presses him to take at once certain steps to ensure their ultimate success. He disclaims any desire to see them applied in any revolutionary way to existing institutions; he is quite willing that those who disagree with him should be free to act in accordance with their several convictions. But he implores the Pope to protect with his irresistible pontifical power Bacon himself and those who shared his views, that they may pursue their scientific work without fear of persecution, and also to provide them with the means essential to its prosecution—books, instruments, physical and chemical laboratories, and astronomical observatories. He sets before him all the inducements which he thought would influence him, especially the great benefits which the Church would reap in finding the Faith buttressed by scientific knowledge and in arming herself with the weapons of war which science alone could provide wherewith to withstand the impending onslaughts of Antichrist.[13]

[12] *Opus Majus*, II 169–172; I 38–41. *Opus Tertium*, pp. 74–77, 84, 86.

[13] Gasquet *Fragment*, pp. 502–505. *Opus Majus*, I 31–32, 399–402; II 221. *Opus Tertium*, 34–38, 41, 59, 85–86.

While Bacon was well aware that his proposals were revolutionary and would be bitterly opposed by many, it may be doubted whether he realized the full sweep of the revolution to which their adoption might lead. He seems to have regarded his two ultimate criteria of truth, authority and experience, as coördinate principles, each independent of the other. His recognition of spiritual experience as an ultimate source of truth opens the way to private judgment in matters of faith; his assertion that it is a psychological impossibility to believe with full assurance anything not established by the evidence of the senses not only makes science independent of revelation, but implies the possibility of bringing revelation before the bar of science for judgment. It may be that Bacon, orthodox Churchman as he believed himself to be, never seriously contemplated the possibility of conflict between his ultimate sources of truth,[14] but it is scarcely to be believed that in the animated debates of the University of Paris so vulnerable a point in his doctrines had been overlooked. Bacon must have known that this and many others of the beliefs to which he would convert the Pope, beliefs in astrology, for example, alchemy, and magic, in the influence of the stars upon the conception of Christ and the propriety of the Church's employing magic as a weapon against Antichrist,[15] would be denounced by many and influential theologians as damnable heresies. He must have known that if the Pope listened to them rather than to him, his temerity in trying to con-

[14] That Bacon was not quite frank with the Pope, that at heart he recognized and knew he recognized no authority as superior to that of experience, is perhaps indicated by two passages found only in the Vatican manuscript 4091 (see Little's bibliography in *Roger Bacon: Essays contributed by various writers on the occasion of the Commemoration of the Seventh Centenary of his Birth*, collected and edited by A. G. Little, Oxford, 1914, p. 385, n. 1), the concluding sentences of which express nearly the same idea. The first reads (Bridges, III 180): "And if the syllogism (*argumentum*) does not suffice for the certification of truth, much less does authority suffice, for it is weaker than reason; and syllogistic reasoning has force (*argumentatio habet virtutem*) when through reason it acquires a sound foundation. This (experimental) science, therefore, aims to show that no confidence should be placed in syllogism or authority unless one has some empirical evidence of greater or less weight (*vult docere quod non est confidendum argumento aut auctoritati nisi aliqua experientia fortis vel levis habeatur*)." The two passages may have been expunged to avoid offence, but it may also be that Bacon removed them because he really had in mind only human, fallible authorities and saw that his words included the authority of Church and Scripture.

[15] *Opus Majus*, I 267–268, 402.

vert the Vicar of Christ might well result in sending him to the stake.

The risk was great, but the issue was worthy of the risk. For the moment the mightiest power on earth—and no other power would suffice to inaugurate the reforms which Bacon had in view—was lodged in the hands of a man singularly enlightened, conscientious, strong of will. To win his approval might be difficult, but it was not beyond the range of possibility. Bacon saw the unique opportunity, and, regardless of personal danger, seized it. If he had succeeded, he probably would have hastened by several centuries the dawn of modern science.

It is this that gives Roger Bacon his unique position in mediaeval thought. Of all the millions that lived between the downfall of the ancient culture and the dawn of modern science, he alone not only discerned clearly the intellectual evils of the age and pointed out the way of escape, but at the risk of his life strove to turn the tide of history into that new channel.

But Bacon failed. The *Opus Majus*, at least, reached the Vatican, for Monseigneur Pelzer recently discovered in the Vatican Library the actual copy despatched by Bacon to the Pope with his autograph notes upon the margin; but there is still nothing to show even that the Pope read the books, much less that he was favorably impressed by them. Only a few months thereafter, November 29, 1268, Pope Clement died, and with him died Bacon's hopes.

Of the next ten years of his life little is known. To these years are referred several of his works, notably (1272) the *Compendium of the Study of Philosophy*, in which the bitterness of a disappointed and despairing man finds vent in savage denunciation of clergy and laity, high and low alike, for their cupidity and viciousness. Nine years after Pope Clement's death the final blow descended. In 1277 the Bishop of Paris issued a sweeping condemnation of heresies alleged to be then prevalent at the University, especially astrology, magic, and Averroism. An anonymous reply, attributed with great probability by Father Mandonnet to Bacon,[16] defends the study of science, including astrology and magic, and accuses the ecclesiastical authorities of ignorance and bigotry. Bacon had for years, by his

[16] P. Mandonnet: *Roger Bacon et le Speculum Astronomiæ* (1277), in *Revue néo-scolastique*, XVII 313–335 (No. 67, août 1910); *Siger de Brabant*, 2me éd. (1911), pp. 238–248.

repudiation of authority and pursuit of forbidden lore, been accumulating the materials for an explosion, and this audacious book was, in all probability, the spark that provoked it. In 1277 he was sentenced to prison by the Minister-General, Jerome of Ascoli, afterwards (1288–92) Pope Nicholas IV, and his doctrines were condemned as "dangerous."[17] Only once thereafter, fifteen years after his sentence, his voice speaks again in *Compendium Studii Theologie*, recently published, dated 1292. Nothing is known as to the place or duration of his imprisonment, although it is quite generally assumed that he was released in 1290 or 1292, when, as is known, the newly elected Minister-General of the Order, Raymund Gaufredi, liberated other monks who had been sentenced at the same time and for similar offences. A confused and seemingly self-contradictory note in a manuscript of one of Bacon's alchemical works also attributes his release to Raymund. The best authority for the date of Bacon's death, John Rous, states that he was buried in the Grey Friars at Oxford, June 11, 1292.

The greater part of Bacon's scientific work probably was done, as I have shown, during the years 1237 to 1257. After he became a friar he must have been seriously hampered by lack of money and the opposition of his superiors even before his imprisonment; thereafter it is difficult to imagine how he could have carried on much important experimental work. As to the actual results attained by him during those years of labor, little evidence has hitherto been available. More than once he speaks of himself as being in possession of important secrets of science,[18] which he feels obliged to conceal from the vulgar, and in many passages he specifies some of the marvellous achievements, possible or actual, of experi-

[17] Since the fact of Bacon's imprisonment has been disputed, I reprint Mr. Little's translation (*Essays*, p. 26) of the entry in the *Chronicle of the XXIV Generals* (the Latin text will be found in Bridges, III 158): "This Minister-General, brother Jerome, by the advice of many friars, condemned and reprobated the teaching of Friar Roger Bacon of England, master of sacred theology, as containing some suspected novelties, on account of which the same Roger was condemned to prison—commanding all the friars that none of them should maintain this teaching but should avoid it as reprobated by the Order. On this matter he wrote also to Pope Nicholas (III), in order that by his authority that dangerous teaching might be completely suppressed."

[18] *De Secretis Operibus Artis et Naturæ* in Brewer, *Opera Inedita*, p. 545. *Un Fragment inédit de l'Opus Tertium*, éd. Duhem, pp. 182–183. *Part of the Opus Tertium*, ed. Little, pp. 80–82.

mental science. Among them are explosives, incandescent lights, a small instrument for the multiplication of power, the use of mirrors and lenses to make small objects seem large and large small, distant objects to seem near and near distant, to make images appear in the air, and to set fire to distant objects by focussing the rays of the sun upon them. It is not impossible that these discoveries were known to him. But these statements are associated with others which cannot be so interpreted, as, for example, that a magnet attracts all metals as well as iron, that vinegar attracts a falling stone, that the severed parts of plants and animals exert reciprocal attraction one upon another. It is indeed quite evident that Bacon had been so deeply impressed by discoveries actually known to him that he had adopted an attitude of uncritical credulity as regards alleged achievements of science; he was, as he frankly admits,[19] ready to believe anything of the kind if reported upon what he took to be good authority. He seems also to have been willing to accept as accomplished fact many achievements which were as yet merely inferred, from accepted principles, to be possible, and as the accepted principles were often quite wrong, some of Bacon's predictions and assertions seem, even in this age of invention, absurdly mistaken. One is not, therefore, justified in taking those of his statements which seem to imply knowledge of the microscope and telescope as affording trustworthy evidence that he had any empirical knowledge of those instruments.

There are, however, certain other considerations, hitherto generally ignored by writers on the subject, which make it probable that Bacon's statements suggesting empirical knowledge of the microscope and the telescope are something more than mere deductive forecasts. These considerations tend, indeed, to show that Bacon was the first man known to us, with the possible exception of his friend Peter of Maharncuria, who possessed the qualifications which the discoverer of those instruments should possess.

Bacon, of course, shared his contemporaries' knowledge of the magnifying properties of the simple lens and of concave, spherical, and parabolic mirrors. These had been known for centuries and are, for example, fully explained by geometrical principles in the chief authority used by Bacon, Alhazen. Some of these explana-

[19] Duhem, *op. cit.*, pp. 152–153; Little, *Frag. Op. Tert.*, p. 49; *Opus Majus*, II p. 219.

tions had already been formulated in the terms still used, *e.g.*, that the apparent size of the object depends upon the size of the visual angle, and that the size of that angle is modified by convex and concave mirrors and by lenses.

But Alhazen treats these properties merely as capable of causing illusions of vision; neither he nor Vitellio betrays any consciousness of the possibility of applying them to the practical end of increasing the power of vision as regards very small or very distant objects. This idea was perfectly familiar to Bacon. He recurs to it in his works again and again. He believed that telescopes had been made in the past; that they had, for example, been used by Julius Caesar in order to spy upon his enemies in Britain from the coasts of France,[20] and was eager to see them again constructed in order to aid the Church in her war against Antichrist.[21]

The failure of Bacon's predecessors to refer to this important possible application of optical theory to practice is not to be explained by mere preoccupation with theory, for they devote considerable space to the no less practical application of theory to the construction of burning mirrors, but by the fact that the idea never had occurred to them. Yet the honor of first conceiving it does not belong to Bacon, but to his great teacher, Robert Grosseteste, who, in his treatise *On the Rainbow and the Mirror*, deduces this possibility from the laws of optics and states it in language that leaves nothing to be desired in clearness and breadth of generalization. In fact, the passage so often quoted to prove Bacon's knowledge of the microscope and telescope is nothing more than a condensed quotation from Grosseteste's work.[22]

[20] *Opus Majus*, II 165; *Opera Inedita*, p. 534.

[21] *Opus Majus*, II 221–222.

[22] This vitally important fact seems to have been first observed by Baur (*Die Philosophie des Robert Grosseteste*, in Baeumker's *Beiträge zur Gesch. d. Phil. d. Mittelalters*, XVIII [1917], p. 114, n. 1). Comparison of the two texts throws no little light upon the methods by which some of Bacon's forecasts were reached:

Bacon	Grosseteste
Opus Majus, II 165.	*de Iride*, ed. Baur, *Beitr.*, IX (1912), 74, 1–7
"We can give transparent substances such shapes and arrange them in such a way with reference to our sight and things that the rays will be broken and bent	"For this part of Perspective, when well understood, will show us the way in which we may make very distant things seem very near, and how we may make very large things near at hand seem very short, and how we may make small things

It would, then, appear that Bacon and his friend Peter had a definite conception of the end to be attained, an eager desire to attain it, and the greater part of the requisite theoretical knowledge. There remains one other essential condition, command of the practical mechanical skill without which such instruments could not be made. There can be no doubt that at that time such

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whithersoever we will, so that we may see a thing near or far under any visual angle we will. Thus at an incredible distance we might read the tiniest of letters and count dust or sand by reason of the magnitude of the visual angle under which we see them, and the largest bodies, though near, we would scarcely see at all because of the smallness of the angle, for distance does not contribute to these appearances, except incidentally, but the size of the angle."

far off seem as large as we please, so that it may be possible for us to read the tiniest of letters at an incredible distance or count sand or grain or grass or any tiny objects.

(*ll.* 7–12, *the fact of refraction;* 12–24, *deductive proof that refraction is necessary;* 25–p. 75, 5, *the angle of refraction is half that between the prolongation of the ray and the perpendicular to the surface;* 6–14, *apparent location of image.*)

(*Inferences*, 15–32). If then these points have been made clear, namely, (1) the size of the angle of refraction at the point of contact between two transparent substances, (2) the place of appearance of an object seen through several such substances, and if one add to these the principles which the student of optics borrows from the natural philosopher, namely, (3) that the apparent size, situation, and position of the object seen depend upon the size of the visual angle and the situation and position of the rays, and also (4) that great distance does not make an object invisible, except incidentally, but the smallness of the visual angle, then, (1) by geometrical reasoning, given a transparent substance of known size, shape, and distance from the eye, it will be perfectly manifest what the apparent place, size, and position will be of an object of known distance, size, and position, and (2) to the same persons will be manifest the method of so shaping transparent substances that they will receive the rays proceeding from the eye at any visual angle one pleases and will constrain the rays received in any way one pleases upon the visible objects, whether they be large or small, distant or near at hand. And thus all visible objects will seem to be in any situation one pleases and of any size one pleases, and, if one pleases, one may make very large objects seem very short and distant objects one

skill was rare in western Europe. Bacon himself says:[23] "These instruments are not made among the Latin-using peoples and could not be made (*fierent*) for two hundred pounds; no, nor for three hundred." It was no doubt for this reason that Peter of Maharncuria made with his own hands the first concave parabolic mirror made in Europe and that Bacon himself was compelled to manufacture his own mirrors.[24] It is likely that the spherical

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may make to seem large and perfectly perceptible by sight."

But the deductive form of the reasoning and the assumption that the law of refraction is analogous to that of reflection and is the same for all substances (Bacon knew better: *Non tamen dividit illum angulum semper in duas partes aequales, licet hoc senserunt aliqui, quoniam secundum diversitatem densitatis medii secundi accidit major recessus et minor fractionis ab incessu recto, Opus Majus*, II, 466), indicate that Grosseteste is merely predicting possibilities without empirical knowledge of the facts.

[23] *Opus Tertium*, p. 35.

[24] *Opus Majus*, I 116; *Opus Tertium*, pp. 46, 111, 113, 116; Little: *Essays*, p. 6, n. 3. Bacon gives some interesting details as to the making of these mirrors, which were so important to the history of science. The first was unfinished early in 1266 (*Opus Majus*, I 116), and he suggests that the Pope might command (and so ensure) its completion. When he first speaks of it in the *Opus Tertium*, about a year later, it is nearly done; soon thereafter it is completed. Peter tried to follow the instructions of the book *De Speculis comburentibus* (by Alhazen, see E. Wiedemann, *Zur Gesch. d. Brennspiegel* in *Annalen d. Physik u. Chemie*, N. F., XXXIX 126–128), but "because the author has deliberately concealed much of the method, saying that he has put the remainder in another book, which has not yet been translated for the Latin-using peoples," many difficulties were encountered. But after devoting no less than three years to the work, to the exclusion of all his studies and other necessary pursuits, during which he expended upon it 100 Parisian pounds (equivalent to about $2500), he at last succeeded. "He would not have left the task undone for 1000 marks, not only for the view it gave him of the exquisitely beautiful power of science, but also because he could thereafter make better ones at less expense, for experience had taught him what he had not known before. Nor is it surprising that he spent so much money and labor on his first task, for no one among the Latin-using peoples before him had known how to go about it, and it is astonishing that he dared attempt a task so unfamiliar and so arduous." Of his own experience Bacon says: "The first mirror cost 60 Parisian pounds, which are worth about 20 pounds sterling, and afterwards I managed to make a better one for 10 Parisian pounds, that is for 5 marks sterling, and after that, as a result of my diligent experimentation with them (*diligentius expertus in his*), I perceived that still better ones could be made for 2 marks or 20 shillings or even for less." Reckoned in purchasing power of the present day, Bacon's mirrors cost him respectively about $1500, $250, $100, $75, "or less."

One may even venture a conjecture as to the improvements in method which so greatly reduced the cost of the mirrors. Alhazen (since his book is not accessible to

crystal lens which he sent the Pope as a gift, by John, was also his own handiwork. At all events one may infer that such a lens was a rarity which the Pope probably would not possess and could not easily procure, and also that Bacon either had or could procure others.

Since the first concave parabolic mirror was not made until 1268, it follows that Bacon could not have had a mirror of that type wherewith to experiment at an earlier date, but it by no means follows that he had no concave spherical mirror; on the contrary it is probable that the comparatively easy task of making the latter was successfully accomplished before the more difficult was undertaken. And if he possessed lenses and concave spherical mirrors, provided the latter were small portions of spheres of large radius, he had the materials necessary to the discovery of the compound microscope, the refracting and the reflecting telescope. For, although a parabolic mirror makes a better reflector for a telescope than a spherical, one of the latter type may be so made as to give very satisfactory results. Sir Isaac Newton, indeed, who rediscovered the reflecting telescope, always used in his instruments a mirror of this kind.

If then Bacon had the fundamental theoretical principles, the requisite mechanical skill, a clear conception of the end to be attained, and a determination to succeed, it is not in the least improbable that he did succeed.

But the question is not one of mere probability. It has long been known that there exists direct, positive, and uncontradicted

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me I here depend upon Wiedemann's outline of its contents) directs that the parabolic mirror be built up out of sections of a paraboloid of revolution, but refers to another work for a description of the instrument by which these sections are to be constructed. This must be the omission to which Bacon above refers, and this is the method which Peter used. Vitellio, Bacon's contemporary, gives (IX 44) a much simpler method, which is, essentially, the making of a steel file with parabolic edge wherewith the cavity which is to be polished as a mirror is filed in a block of iron. Bacon (*De Speculis*, ed. Combach, 1614, pp. 202–204), by a similar method, makes a ruler with a parabolic edge and turns the cavity in a block of wood in such manner that all points of the surface will conform to the edge of the ruler. It is not impossible that Vitelo's method is that to which Bacon refers as invented by Peter, which he probably himself used in the construction of his first mirror; the substitution of wood for steel and iron as the materials to be worked would explain the reduction in the cost of the other mirrors (*Opus Tertium*, p. 111).

evidence to the fact that Bacon left in writing instructions for the making of a "perspective glass" or reflecting telescope, and that, in accordance with those instructions, Leonard Digges made such a telescope prior to 1571. Digges's telescope was constructed of mirrors set at due angles, one to the other, together with a lens "for the multiplications of beames," that is, for the magnification of the focal image produced by the concave mirror. It was of sufficient power to bring out the details of objects not clearly distinguished by the naked eye at a distance of seven miles with a degree of distinctness which was satisfactory to its manufacturer and his friends.[25]

[25] The extreme rarity of Digges's books, which is perhaps one of the reasons for the general disregard of the evidence which they contain, is sufficient excuse for quoting the relevant passages in full:

"A Geometrical Practical Treatize named Pantometria, divided into three Bookes, Longimetra, Planimetra, and Stereometria . . . first published by *Thomas Digges* Esquire and dedicated to the Graue, Wise and Honourable, Sir *Nicholas Bacon* Knight, Lord Keeper of the great Seale of England." (First edition, 1571; quotations from second edition, London, 1591. From the letter of dedication it appears that this work was one of several which Leonard Digges, Thomas's father, "in his youthe time long sithens had compiled in the English tongue," but Thomas has "supplied such partes of this Treatise as were leaft obscure or vnperfect, adioyning therevnto a Discourse Geometricall of the fiue regulare or Platonicall bodyes.")

P. 28: "But marueilous are the conclusions that may be performed by glasses concaue and conuex of Circulare and parabolicall formes, vsing for multiplication of beames sometime the aide of Glasses transparent, which by fraction should vnite or dissipate the images or figures presented by the reflection of other. By these kinde of Glasses or rather frames" (*i.e.*, systems) "of them, placed in due Angles, yee may not onely set out the proportion of an whole region, yea represent before your eye the liuely image of euery Towne, Village, etc., and that in as little or great space or place as ye will prescribe, but also augment and dilate any parcell thereof, so that whereas at the first apparance an whole Towne shall present it selfe so small and compact together that yee shall not discerne anye difference of streates, yee may by application of Glasses in due proportion cause any peculiare house, or roume thereof dilate and shew it selfe in as ample forme as the whole towne first appeared, so that ye shall discerne any trifle, or reade any letter lying there open, especially if the sunne beames may come vnto it, as plainely as if you were corporally present, although it be distante from you as farre as eye can descrie: But of these conclusions I minde not here more to intreate, hauing at large in a volume by it selfe opened the miraculous effects of perspective glasses." (This volume was never published.)

Op. cit., second page of Preface (by Thomas Digges): ". . . *my Father by his continuall painfull practises, assisted with Demonstrations* Mathematicall, *was able, and sundrie times hath by proportionall Glasses duely situate in conuenient Angles, not onely discouered things farre off, read letters, numbred peeces of money with the verye coyne and super-*

Leonard and Thomas Digges belonged to a Kentish family of gentry which had played an honorable part in the history of England for more than two hundred years. They were themselves sound scholars, reputed the best mathematicians of their time in England and highly esteemed by such shrewd judges of character as Sir Nicholas Bacon and Sir Francis Walsingham. Their evidence, until discredited by more trustworthy evidence to the contrary, is entitled to full credence, and establishes the fact that Roger Bacon left intelligible instructions in writing for the construction of a reflecting telescope.[26]

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scription thereof cast by some of his freends of purpose upon Downes in open Fields, but also seuen Myles off declared what hath beene doone at that instant in priuate places: Hee hath also sundrie times by the Sunne beames fixed (fired?) *Powder, and dischargde Ordinance halfe a Mile and more distante, which things I am the boulder to report, for that there are yet liuing diuerse* (*of these his dooings*) Oculati testes, *and many other matters farre more strange and rare which I omit as impertinent to this place.*"

"An Arithmeticall Militare Treatise, named *Stratiokos:* . . . Long since attempted by *Leonard Digges* Gentleman, Augmented, digested, and lately finished, by *Thomas Digges*, his Sonne." (First edition, London, 1579.)

P. 189 (appendix by Thomas): "And such was his (Leonard's) Foelicitie and happie successe, not onely in these Conclusions, but also in the Optikes and Catoptrikes, that he was able by Perspectiue Glasses duely scituate vpon conuenient Angles, in such sorte to discouer euery particularitie in the Countrey rounde aboute wheresoeuer the Sunne beames mighte pearse: As sithence Archimedes (Bakon of Oxforde only excepted) I haue not read of any in Action euer able by meanes naturall to performe ye like. Which partely grew by the aide he had by one old written booke of the same Bakons Experiments, that by straunge aduenture, or rather Destinie, came to his hands, though chiefelye by conioyning continual laborious Practise with his Mathematical Studies."

[26] It has not, I think, hitherto been observed that Dr. John Dee, admirer of Bacon and collector of his works, in whose possession the Voynich manuscript almost certainly was, who was also an intimate friend of Thomas Digges and probably of his father, also had a "perspective glass." On p. 1 of his private diary (*A True and Faithful Relation of What passed for many Years Between Dr. John Dee . . . and Some Spirits*, edited by Meric Casaubon, London, 1659) Dr. Dee describes, May 28, 1583, a little girl-spirit as "playing by herself, and diverse times another spake to her from the corner of my study by a great Perspective-glasse." I am indebted to Mr. Voynich for two other significant scraps of information. Thomas Harriot, afterward famous as a mathematician, was in his youth a member of the group of scientists at Elizabeth's court and accompanied the second expedition sent by Sir Walter Raleigh to "Virginia" as geographer, remaining there a year, 1585–1586. In his account of the country (Hakluyt, *Voyages*, VI 189, in the *Everyman's Library* edition) he says: "Most things they (the Indians) sawe with us, as Mathematicall instruments, sea Compasses, the

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This conclusion is confirmed by the legend attached to Bacon's drawing of a spiral nebula in the Voynich manuscript, which, if it has been correctly deciphered, states that the object in question was seen "in a concave mirror," that is, a reflecting telescope. But this legend is so difficult to read that I would not adduce it as independent evidence of Bacon's possession of a telescope until the reading has been revised and verified.[27]

That Bacon possessed a telescope I regard as an established fact, independently of the new evidence afforded by the Voynich manuscript. But for his possession of a compound microscope, or even of a simple microscope of sufficient power to enable him to make discoveries of real importance, there has been hitherto no evidence at all. At most one may say that, since he had lenses and was familiar with the idea of arranging them in such manner as to increase the size of the visual angle, there is no improbability in the hypothesis that he succeeded in so arranging them as to make the first compound microscope.

The doubt that has overhung the subject is now, in large part, dispelled by Mr. Voynich's discovery. That the author of the manuscript possessed both a telescope and a microscope, both of considerable power, is established by the drawings which it contains. That the author was Roger Bacon is established by the fact that the alphabets which I worked out from the Key on the last page of the manuscript, when applied to the cipher elements interpolated into the Key, spelled out the name *R Baconi*.[28]

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vertue of the load-stone in drawing yron, a perspective glasse whereby was showed many strange sights, burning glasses . . . were so strange to them . . . they thought they were rather the workes of gods than of men," etc. Dee also had a trick mirror, the theory of which was known to Bacon (*Opus Majus*, II 138). This mirror was much admired by Queen Elizabeth (Dee's *Private Diary*, Camden Soc., 1842, pp. 29–30) and was ultimately given to Emperor Rudolph. I agree with Mr. Voynich's inference that this mirror had its origin, as well as the telescopes owned by Harriot, Dee, and Digges, in the same Bacon manuscript mentioned by Thomas Digges, and that that manuscript probably came from Dee's collection of the Bacon manuscripts.

[27] [See Chapter XI.]

[28] The first section of the Key reads: *michiton oladabas multos te tccr cerc portas*. The *o* of *multos* is built up out of three elements, *c*, *e*, *q*, which form a monogram for *a*. Subtracting the Latin sentence *Michi dabas multas portas*, one has as residuum the interpolated cipher elements *ton ola te tccr cerc*. Between June and September, 1919,

But whether the microscope with which he saw the spermatozoa and the cells which he has so clearly depicted in the drawings was of the simple or the compound type will remain an open question until the manuscript has been deciphered. Some students are of the opinion that a simple lens of high power would have sufficed; whether this is the case or not I must leave to the decision of those more competent to judge than I am.

It would appear, then, that it was only during the twenty years from 1237 to 1257 that Bacon enjoyed comparative freedom and possessed sufficient money for the prosecution of his scientific work. During those years he made what he regarded as scientific discoveries of the utmost importance, and it is extremely probable that the telescope and the microscope, in some form, were among them. Thereafter, for thirty-five years or more, he worked, when permitted to work at all (for at least some of those years were passed in prison), under severe restrictions, closely watched by suspicious and hostile eyes. The majority of his contemporaries, and very many among those of position and power, would have seen in his achievements conclusive proof of commerce with the devil, and many, even of the more enlightened, would have found in his teachings equally

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I worked out from the Key a system of biliteral alphabets and assigned them trial values based upon the usual alphabetic order. Early in September it occurred to me to apply these values to the cipher syllables above given. I found that *tccr cerc* spelled *-coni*, that *ton*, analyzed into *to on*, spelled the biliteral symbol *sl*, to which I had given the values *r* or *q;* that *ol la* spelled *iq*, the value of which was *e* or *b*. Thus I had at once as a possible reading *R B coni*. But the symbol *te* was not in my system of alphabets at all. That its value is *a* is now assured by many hundred occurrences.

[These values are "alphabetic" and not "phonetic"; see p. 85. Thus *ce*, in the auxiliary alphabet by conversion, is (alphabetic) *t*, and *eq*, by the secondary alphabet, is (alphabetic) *b*; *tb* is not a base, but reverts to *oi*, which, in the secondary alphabet by reversion, has the (alphabetic) value *a*. In the next group, *to*, by the primary alphabet, is (alphabetic) *s*, and *on*, in the auxiliary alphabet by conversion, is (alphabetic) *l*; *sl*, in the auxiliary alphabet by conversion, is (alphabetic) *r*. Then *ol* and *la*, in the primary alphabet, are respectively *i* and *q* (both alphabetic); and *iq*, in the secondary alphabet by reversion, is (alphabetic) *b*. Of the remainder, *te*, in the primary alphabet, is (alphabetic) *a*; *tc*, by the secondary alphabet, is (alphabetic) *c; cr*, in the auxiliary alphabet by conversion, is (alphabetic) *o*; *ce*, in the secondary alphabet, is (alphabetic) *n*; *rc*, in the auxiliary alphabet by conversion, is (alphabetic) *i*. The use of alphabetic values in this interpretation cannot be too strongly insisted upon, since the point is nowhere made clear in Newbold's manuscripts, and the interpretation baffled the Editor for many hours.—RGK]

good reasons for sending him to the stake.[29] He must, therefore, as a mere ordinary precaution, have been compelled to keep these discoveries secret, either locked up in his own breast or at most communicated to a few trustworthy friends. What would have been his reaction against such circumstances as these? What course of action would they have driven him to adopt?

In the Voynich manuscript is found the answer to these questions, but any one familiar with Bacon's works could have predicted his course of action without this concrete evidence of what he actually did do.

Bacon's reticence about his discoveries, even before he entered the Franciscan Order, was not entirely, nor, I think, chiefly, due to fear of persecution; it was grounded in his most sacred convictions. He was profoundly religious; in everything he saw the hand of God. The mere fact that the secrets of Nature had then so long been hidden is to him conclusive proof that God wills it so to be. The solitary scholar who succeeds in lifting a corner of the veil has, he believed, been admitted by God to His confidence, and is thereby placed under the most solemn obligation conceivable to make no use of his knowledge which God would not approve. Especially must he be careful not to betray it to the vulgar. God has indeed Himself, with special regard for this contingency, directly inspired scientific men, when writing of their discoveries, to conceal them either in obscure language such as was used by philosophers, or in peculiar technical terms such as were used by alchemists, *or in cipher*.[30]

[29] Even so enlightened a scholar as Dante, writing within a few years of Bacon's death, regards the practice of alchemy as an offence punishable by damnation. *Inf.*, xxix, 118: One of the damned confesses,

> *Ma nell' ultima bolgia delle diece*
> *Me per l'alchimia che nel mondo usai,*
> *Dannò Minos, a cui fallir non lece.*

Dante mentions several persons who had recently been burned, either as alchemists or as would-be counterfeiters by alchemical means.

[30] *Opus Majus*, I, p. 11: "Many are called, but few chosen, for the reception of philosophical truth, and likewise for that of scientific truth."

Ib., p. 10: "One should not cast pearls before swine, for whosoever reveals mysteries derogates from the majesty of the universe, and those things which the mob is permitted to share do not remain secrets. . . . Hence, Aristotle in the *Book*

That Bacon had devoted much study to the subject of ciphers is apparent from the eighth chapter of his *Letter on the Secret Works of Art and the Nullity of Magic*, in which he enumerates and describes no less than seven modes of concealing ideas:[31] "The man is insane who writes a secret in any other way than one which will conceal it from the vulgar and make it intelligible only with difficulty even to scientific men and earnest students. On this point the entire body of scientific men have been agreed from the outset, and by many methods have concealed from the vulgar all secrets of science. For some have concealed many things by magic figures and spells, others by mysterious and symbolic words. For example, Aristotle in the *Book of Secrets* says to Alexander, 'O Alexander, I wish to show you the greatest secret of secrets; may the Divine Power help you to conceal the mystery and to accomplish your aim. Take therefore the stone which is not a stone and is in every human being and in every place and at every time, and it is called the Egg of the Philosophers, and Terminus of the Egg.' Innumerable examples of the kind are to be found in many books and divers sciences, veiled in such terminology that they cannot be understood at all without a teacher. The third method of concealment which they have employed is that of writing in different ways, for example, by consonants alone, so that no one can read it unless he knows the words and their meanings. In this way the Hebrews and the Chaldaeans and Syrians and Arabs write their secrets. Indeed, as a general thing, they write almost everything in this way, and therefore among them, and especially among the Hebrews, important scien-

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of Secrets says he would be breaking the heavenly seal if he were to betray the secrets of Nature."

Duhem, *Fragment*, p. 182: Little, *Fr. Opus Tertium*, p. 81: "It is foolish to offer an ass lettuce when thistles are good enough for him. The mob and its leaders know not how to make proper use of precious things, but pervert all to evil ends, for one wicked man, if he knew these secrets, could throw the whole world into confusion. The inmost secrets of science have therefore always been hidden by scientists, and have been written in such manner that even the wisest of men can penetrate the knowledge of them by hard study only. This *God has ordained and has inspired all to whom He has given these secrets*, and every one of them clearly perceives that, for the above-said reasons, they are not to be communicated. I therefore may not write these things in contravention of the will of God and the teaching of the wise in such manner that they could be understood by any and every one."

[31] Brewer, *Opera Inedita*, p. 544.

tific knowledge lies hidden. For Aristotle in the book above mentioned says that God gave them all scientific knowledge before there were any philosophers, and that from the Hebrews all nations received the first elements of philosophy. . . . In the fourth place, concealment is effected by commingling letters of various kinds; it is in this way that Ethicus the astronomer concealed his scientific knowledge by writing it in Hebrew, Greek, and Latin letters in the same written line.[32] In the fifth place, certain persons have achieved concealment by means of letters not then used by their own race or others but arbitrarily invented by themselves; this is the greatest obstacle of all, and Artephius has employed it in his book *On the Secrets of Nature*.[33] In the sixth place, people invent not characters like letters, but geometrical figures which acquire the significance of letters by means of points and marks differently arranged; these likewise Artephius has used in his science.[34] In the seventh place, the greatest device for concealment is that of shorthand, which is a method of noting and writing down as briefly as we please and as rapidly as we desire; by this method many secrets are written in the books of the Latin-using peoples. I have thought fit to touch upon these methods of concealment *because I may, perhaps, by reason of the importance of my secrets, employ some of these methods*, and it is my desire to aid in this way, at least *you*, to the extent of my ability."

It is quite characteristic of Bacon that this specious pretence of good-will really masks a deliberate intention to deceive, for the list contains not a hint which would aid any one in unravelling the system of ciphers which he himself uses; it is indeed drawn up expressly to mislead the would-be decipherer by directing his attention to forms of cipher which have no place in that system.

Finally, we know that Bacon was deeply concerned to hand down to future generations the results of his labors. The whole burden of the voluminous work addressed to Pope Clement in 1267 is for

[32] The cipher alphabets extant in manuscripts of Ethicus (facsimiles in Wuttge's edition of *Aithikos*) are not of this kind.

[33] What purport to be the ciphers of Artephius will be found in Cardanus's *de rerum vanitate*, lib. xvi, c. 90 (*Opera Omnia*, tom. III, p. 312).

[34] This seems to be the cipher described by S. L. MacGregor Mathews (*The Kabbalah Unveiled*, third impression, New York, 1912, pp. 10–11) as the "Qabalah of the Nine Chambers."

official recognition of that work, for complete reformation of the conditions under which it was prosecuted, for repression of ignorant opposition, for endowment of research. But long before his appeal to the Pope, Bacon had taken steps to ensure the perpetuation of his ideals. He had probably taken into his confidence a few friends of his own generation, but he had certainly looked beyond his generation. He mentions specifically two boys whom he had trained in his methods, and it is not unlikely that there were others. One of these two, John, Bacon says he found on the streets of Paris at the age of fifteen, penniless and starving. For six years he has provided him with food, clothing, and education, and now, at the age of twenty-one, he sends him to Rome to the Pope as his trusted representative and bearer of the most precious of his manuscripts, informing the Pope that John is more competent than any living scholar, however learned, to explain to him anything he may find difficult of comprehension. Bacon's object in training these boys, he himself explains,[35] was that "they might be useful vessels in the Church of God in ordering aright, by the grace of God, the entire course of study of the Latin-using peoples." In other words, they were to be Bacon's torch-bearers, handing on to the next generation the flame kindled and nurtured by him, the spirit of pure science as we understand it today.

It was then, in all probability, for John or for some other such trusted friend or friends that Bacon wrote this precious manuscript, which now, after more than six hundred years of concealment, has been rescued by the intuitive genius of Mr. Voynich from imminent peril of destruction, and has been brought to light for the instruction of our own generation. Twenty years of free and independent research, during which he had often experienced that rapture of discovery which he so feelingly describes, had been followed by long years of hampering restrictions, enforced silence, and daily intensified despair. He felt himself buried alive, and the fruits of his labors seemed destined to be finally buried with him in the Friary Church at Oxford. It was under these circumstances that he conceived the plan which was to thwart his opponents. He had long since devised and used a cipher of extraordinary ingenuity in which at once to record his discoveries and to conceal them

[35] *Opus Majus*, II 171.

from prying eyes. He resolved to embody in a single work, concealed in that cipher, his most important discoveries together with his own interpretation of their significance, to provide it with a key so constructed that it could be understood and used only with the aid of oral instruction, and to entrust the secret of its use to some faithful friend in the hope that in a more sympathetic age the fruits of his labors would come to light. That age was not to dawn as soon as he had hoped, and the secret probably died with the friend with whom he entrusted it. But at last, after the lapse of more than six hundred years, the dawn has come and the secret of the cipher has been unravelled. Difficulties, formidable difficulties, still bar the way to the reading of Bacon's manuscript, but they are less formidable than those which have been overcome. These also must be overcome before the full story can be told. But even with the text unread the drawings alone throw a flood of light upon the achievements of Roger Bacon. They confirm to the full the inference drawn by a few scholars from existing evidence, but denied by the majority, that he possessed and was probably the discoverer of the telescope and the microscope; they prove that he had seen anatomical and astronomical objects never seen by the human eye before, and not to be seen again for centuries, and show that he is here trying to weave them into and interpret them by a preconceived system of ideas drawn in the main from the Platonic tradition. Roger Bacon at last stands revealed as one of the greatest of the many men of genius born of the gifted English race: the true Forerunner of Modern Science.

CHAPTER II

The Voynich Cipher Manuscript of Roger Bacon

SKETCH OF ITS HISTORY

[Before I take up the story of my studies in the cipher writings of Roger Bacon, it might be well to give some account of that manuscript with which all such studies must start, without which such studies would have been impossible, without which such studies might never have been thought of: the great cipher manuscript which has come into the possession of Mr. Wilfrid M. Voynich, the well-known bibliophile of New York and London. The account which I shall here present is the product not of my own investigations, but of those of Mr. Voynich, to whom the credit for the discoveries is due.[1]]

In 1912, during one of his periodic visits to the Continent of Europe, in quest of old books and manuscripts, Mr. Voynich came across a most remarkable collection of precious illuminated manuscripts. For many decades these volumes had lain buried in the chest in which he found them in an ancient castle in Southern Europe, where the collection had apparently been stored in consequence of the disturbed political condition of Europe during the early part of the nineteenth century. Most of these manuscripts must formerly have belonged to the private libraries of various ruling houses of Italy, now extinct, since many of them were embellished with the arms of such personages as the dukes of Parma, Ferrara, and Modena.

While he was examining the manuscripts, with a view to the acquisition of at least a part of the collection, his attention was especially drawn by one volume. It was such an ugly duckling compared with the other manuscripts, with their rich decorations in

[1] [The remainder of this Chapter is a slightly rewritten and revised version of Mr. Voynich's address given at the College of Physicians in Philadelphia, as an introduction to Professor Newbold's lecture, on April 20, 1921. It was printed in the *Transactions of the College of Physicians of Philadelphia, 1921*, pages 415–430, and is utilized here by permission of the College of Physicians and of Mr. Voynich.—RGK]

gold and colors, that his interest was aroused at once. It proved to be written entirely in cipher. Even a necessarily brief examination of the vellum upon which it was written, the calligraphy, the drawings, and the pigments suggested as the date of its origin the latter part of the thirteenth century. The drawings indicated it to be an encyclopedic work on natural philosophy. Mr. Voynich hastily considered the question of the possible authorship of the work, and the names of the only two thirteenth century scholars who could have written on such a variety of subjects occurred to him: first, Albertus Magnus, who was at once eliminated from consideration because his ecclesiastic and political position was such that it could not have been necessary for him to conceal any of his writings in cipher, and, second, the Franciscan friar Roger Bacon, an infinitely greater scholar, who had been persecuted on account of his writings and whose scientific discoveries had been misrepresented as black magic. Moreover, for many years he had been forbidden by his Order to write, and he himself referred in his works to the necessity of hiding his great secrets in cipher. Although Mr. Voynich could not be certain of its authorship, the fact that this was a thirteenth century manuscript in cipher convinced him that it must be a work of exceptional importance, and knowing of no other manuscript of such an early date written entirely in cipher, he included it among the manuscripts which he purchased from this collection.[2]

The manuscript having passed into his possession, two problems presented themselves—the text must be unravelled and the history of the manuscript must be traced. He knew practically nothing about ciphers, and therefore he endeavored to awaken the interest of specialists in this volume, with the result that many American and European scholars made attempts to decipher the manuscript, but without success.[3] Mr. Voynich himself began to work on the less important but extremely fascinating problem of the history of the work.

It was not until some time after the manuscript came into his

[2] He hopes some day to be able to acquire the remaining manuscripts in the collection, and therefore refrains from giving details about the locality of the castle.

[3] [Mr. Voynich added the words, "except Prof. William Romaine Newbold, who, having discovered the key and reconstructed the system of the cipher, has begun to translate the manuscript."—RGK]

hands that he read the document bearing the date 1665 (or 1666), which was attached to the front cover. Because of its late date he had regarded it as of no consequence, and therefore, as he himself frankly admits, had neglected it during his first examination of the manuscript. This document, which is a letter from Joannes Marcus Marci to Athanasius Kircher making a gift of the manuscript to him, is of great significance, as can be seen from the following translation of it:[4]

Reverend and Distinguished Sir, Father in Christ:

This book, bequeathed to me by an intimate friend, I destined for you, my very dear Athanasius, as soon as it came into my possession, for I was convinced it could be read by no one except yourself.

The former owner of this book asked your opinion by letter, copying and sending you a portion of the book from which he believed you would be able to read the remainder, but he at that time refused to send the book itself. To its deciphering

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[4] [A facsimile of the letter is given in Plate I; the Latin text is as follows:]

Reverende et Eximie Dne
in Christo Pater

Librum hunc ab Amico singulari mihi testamento relictum, mox eundem tibi amicissime Athanisi ubi primum possidere cœpi, animo destinavi: siquidem persuasum habui â nullo nisi abs te legi posse. Petijt aliquando per litteras ejusdem libri tum possessor judicium tuum parte aliqua libri â se descripta et tibi transmissa, ex qua reliqua à te legi posse persuasum habuit, uerùm librum ipsum transmittere tum recusabat, in quo discifrando posuit indefessum laborem, uti manifestum ex conatibus ejusdem hic una tibì transmissis, neq̃ prius huius spei quàm uitæ suæ finem fecit. Verùm labor hic frustraneus fuit, siquidem non nisi suo Kirchero obediunt ejusmodi Sphinges. Accipe ergõ modo quod pridem tibi debebatur hoc qualecunq̃ mei ergá te affectus indicium, huiusq̃ seras, si quæ sunt, consueta tibi felicitate perrumpe. retulit mihi D. Doctor Raphael Ferdinandi tertij Regis tum Boëmiæ in lingua boëmica instructor dictum librum fuisse Rudolphi Imperatoris, pro quo ipse latori qui librum attulisset 600 ducatos præsentarit, authorum uerò ipsum putabat esse Rogerium Bacconem Anglum. ego judicium meum hic suspendo. tu uerò quid nobis hic sentiendum defini, cujus favori et gratiæ me totum commendo maneoq̃

Rtiæ Vestræ

Ad obsequia
Joannes Marcus Marci
a Cronland·

Pragæ 19 Augusti
A. D. 1665 (*or* 1666)

he devoted unflagging toil, as is apparent from attempts of his which I send you herewith, and he relinquished hope only with his life. But his toil was in vain, for such Sphinxes as these obey no one but their master, Kircher. Accept now this token, such as it is and long overdue though it be, of my affection for you, and burst through its bars, if there are any, with your wonted success.

Dr. Raphael, tutor in the Bohemian language to Ferdinand III, then King of Bohemia, told me the said book had belonged to the Emperor Rudolph and that he presented to the bearer who brought him the book 600 ducats. He believed the author was Roger Bacon, the Englishman. On this point I suspend judgment; it is your place to define for us what view we should take thereon, to whose favor and kindness I unreservedly commit myself and remain,

At the command of your Reverence,
JOANNES MARCUS MARCI,
of Cronland.

PRAGUE, 19th August, 1665 (or 1666).

Marcus Marci, who wrote this letter, is today nearly forgotten, but among his contemporaries he was held in great repute as physician, mathematician, physicist, and orientalist, and he was rector of the University of Prague. That he was highly esteemed, not merely on the Continent, we know from the fact that the London Royal Society, through Edward Browne, son of Sir Thomas Browne, invited him in 1667 to become a corresponding member of the Society. The invitation, however, came too late, for Marci had died April 10 of that year, at the age of seventy-two years. A few months before his death he entered the Jesuit house at Prague. Before joining the Order he distributed his books among his friends, and in August, 1665 (or 1666), he sent this cipher manuscript to Kircher. The letter, it will be observed, states that Marci had destined the manuscript for Kircher as soon as it came into his possession, since he was convinced, as he says, that such a Sphinx would obey no one but Kircher.

Athanasius Kircher, the celebrated Jesuit scholar, was a man of immense erudition and only a little less credulity, and the author of copious works on every conceivable subject, including several treatises on ciphers and hieroglyphics. Many of his works are studied even today. He was the friend of popes, emperors, kings, and scientists, and Marci had studied under him in Rome. Among his many achievements was the foundation of the museum in Rome which bears his name, the Museum Kircherianum. He did not, however, include this cipher manuscript among his gifts to it, otherwise it would have been entered into the elaborate catalogue

Reuerende et Eximie Dne
in Christo Pater

Librum hunc ab Amico singulari mihi testamento relictum, mox eundem tibi amicissime Athanasi ubi primum possidere cepi animo destinaui, siquidem persuasum habui à nullo nisi a te legi posse. Petijs aliquando per litteras ejusdem libri tum possessor judicium tuum parte aliqua libri à se descripta et tibi transmissa ex qua reliqua à te legi posse persuasum habuit, verum librum ipsum transmittere tum recusavit in quo discifrando posuit indefessum laborem uti manifestum ex conatibus ejusdem hic una tibi transmissis neq prius huius spei quam [illegible] finem [illegible]. Verum labor hic frustraneus fuit, siquidem non nisi suo Kirchero obediunt ejusmodi phinges. Accipe ergo modo quod [illegible] tibi debebatur hoc qualecunq mei erga te affectus indicium, huiusq seras si quae sunt consueta tibi felicitate perrumpe. retulit mihi D. Doctor Raphael Ferdinandi tertij Regis tum Boëmiae in lingua boëmica instructor dictum librum fuisse Rudolphi Imperatoris, pro quo ipse latori qui librum attulisset 600 ducatos prosentarit, authorem verò ipsum putavit esse Rogerium Baconem Anglum. ego judicium meum hic suspendo. tu verò quid nobis hic sentiendum detine, cujus favori et gratiae me totum commendo manecq

Rtiae Vestrae

Praga 19 Augusti
[illegible] 1665

Ad Obsequia

Joannes Marcus Marci
a Cronland.

Plate I

Letter of Marcus Marci to Athanasius Kircher accompanying the gift of the Cipher Manuscript

Courtesy of Wilfrid M. Voynich

of the museum, which was first published at Amsterdam in 1678. Nor does he refer to this precious volume in any of the works published by him from the time he received it in 1665 (1666) until his death in 1680. But that Kircher took an interest in the manuscript is shown by Marci's letter, which reminds him that this is the same manuscript part of which had been copied and sent to him many years earlier by their mutual friend (unnamed), the then owner of the manuscript. Furthermore, the letter tells us that Kircher, upon receipt of these pages, wanted to see the original manuscript, but the owner refused to send it.

There is no direct evidence what Kircher did with the manuscript: and this is not important, because if its subsequent owners, from the time of the death of Kircher to the time when the manuscript was locked up in the chest in which it was found, had taken an interest in it, some reference undoubtedly would be found in the literature of the enlightened eighteenth century. Quite probably Kircher left the manuscript to someone at the Court of Parma, where he had patrons and friends, and it remained in the possession of a member of the Farnese family until, with other manuscripts, it was removed to the collection in which it was found by Mr. Voynich.

The letter of Marci is the clue also to the earlier and much more important history of the manuscript. The first step to be considered in going back was to ascertain, if possible, the identity of the intimate friend of Marci, who, after toiling over this manuscript for many years, had left it to him in his will. Possibly researches in the Bohemian State Archives will lead to the discovery of his name. The period of his ownership of the manuscript has, however, been approximately established.

Marci closes his letter by reminding Kircher that a certain Dr. Raphael once told him that this manuscript had been presented to Emperor Rudolph, that the Emperor had rewarded the messenger with six hundred imperial golden ducats (an enormous sum for that period), and that the manuscript had been attributed to Roger Bacon, the Englishman. Marci hardly facilitated investigation by omitting to mention the surname of Dr. Raphael, but his statement that Dr. Raphael formerly taught the Bohemian language to Ferdinand III was of great assistance in identifying him.

According to the Bohemian biographical dictionaries and information supplied by the director of the Bohemian State Archives,

Dr. Raphael, a lawyer and minor poet, known as Missowsky, after his Polish mother, was born in 1580. He began his career as secretary to Cardinal Melchior Klesl, at the Court of Rudolph. Later, when he was at the Court of Ferdinand II, he was tutor in the Bohemian language to the Emperor's children, one of whom was afterward the Ferdinand III mentioned in Marci's letter. Under Ferdinand III he became attorney-general of Bohemia, and he died in 1644.

As Marci's letter indicates that he had spoken with Dr. Raphael about this manuscript, it is obvious that he must have done so by 1644, the year of Dr. Raphael's death, and this would seem to indicate that in all probability the manuscript was in Marci's possession as early as this. Since the manuscript was bequeathed to Marci, it furthermore suggests that the person who made the bequest did not live after 1644. It is known (as will be shown later on) that a still earlier owner of the manuscript died in 1622, so that investigation as to the identity of this temporarily anonymous owner is narrowed to a period of about twenty-two years. Of course, there is a possibility that during this period the manuscript passed through the hands of more than one owner.

When the manuscript was brought to America, the margins of the first page had the appearance of being blank, but an accident to a photostatic reproduction of this page revealed the fact that an underexposure of the plate brings out a faded autograph in the lower margin. Chemicals were applied to the margins, and the autograph, Jacobus de Tepenecz, became visible, with some illegible figures below it.

Bohemian biographical dictionaries yielded the information that Jacobus de Tepenecz was a Bohemian scientist, ennobled by Emperor Rudolph in 1608. He had the right only from that time to sign himself as "de Tepenecz." Earlier he was known as Horcicky, or, in the Latinized form, Sinapius.[5] At one time he was director of the alchemical laboratory of the Emperor, and from 1601 he was director of the Imperial Botanical Garden. He invented a prototype of *eau de cologne*, calling it *aqua sinapis*, which was used as a universal remedy. The *aqua sinapis* brought him such wealth that he could and did lend the Emperor enormous sums

[5] The director of the Bohemian State Archives kindly supplied Mr. Voynich with a copy of Emperor Rudolph's patent of nobility to Horcicky.

of money, in pledge for which he received the whole district of Melnick. He was on intimate terms with Emperor Rudolph, and is credited with having cured him of a very dangerous illness. He died in 1622, leaving much property to the Jesuits at Prague.

The signature of Tepenecz could not have been placed in the manuscript earlier than 1608, because it was in that year that Horcicky was granted the name of Tepenecz by the Emperor. How he obtained the manuscript remains unknown, but there are two possibilities especially worth considering. Since Dr. Raphael said the manuscript was once in the possession of Emperor Rudolph, either the Emperor, who shared Tepenecz's intense interest in botany and the occult sciences, presented the manuscript to him, or, what seems much more likely, lent it to him for working purposes. During the year following the abdication of Emperor Rudolph, which took place in 1611, many treasures were looted from his museum, and at that time Tepenecz probably felt justified in retaining the manuscript.

Before continuing the history of this manuscript a few facts regarding Emperor Rudolph and his remarkable interests should be recalled. From the time of his election as Emperor of the Holy Roman Empire, in 1576, his passion for art and science, especially alchemy and metallurgy, steadily grew. He formed the largest and most important museum of his time. Soon after his death, its objects, made of precious stones and metals, alone were valued by Boulenger at seventeen million gulden. Under the direction of the celebrated antiquary, Jacobo di Strada, afterward von Rossberg, he gathered together over seven hundred famous pictures for his gallery. He had an observatory built for Tycho Brahe and Kepler, and a botanical garden was founded by him which was under the supervision of such celebrities as Charles de l'Ecluse and Sinapius. Numberless scientists were invited to his famous laboratory—alchemists, chemists, astronomers, metallurgists; and adventurers of all descriptions and political spies from every country found it profitable, though dangerous, to join them. The scientists at his court, however, led a very precarious existence. A successful discovery or experiment sometimes brought wealth and titles to its author; or court intrigues, suspicion of fraud, or the irritable moods of the Emperor resulted in his imprisonment, expulsion, or execution. As the years passed the Emperor came more and more

to neglect the affairs of state, and, as his inherited melancholy developed, he spent most of his time in his alchemical laboratory or in his museum, surrounded only by a few temporary favorites.

The testimony of Dr. Raphael, a contemporary courtier, that the manuscript was once in the possession of Emperor Rudolph is fairly conclusive. The autograph of Jacobus de Tepenecz, who was the Emperor's intimate friend and lived at his palace, confirms the fact that this manuscript had found its way to his court.

Who could have brought this cipher manuscript to him? Who could have convinced the Emperor of its tremendous importance and claim authoritatively that it was the secret work of Roger Bacon? Mr. Voynich examined the biographies of several hundred persons who had visited or lived at Rudolph's court; only one of them yielded results, but that one was a real treasure-find. Of him Shakespeare says that he had volumes which he prized more than his dukedom, and calls him Prospero, but in everyday life he was known as Dr. John Dee.[6] Volumes have been written about him, representing him principally as a great mathematician, astrologer, and necromancer. But some of his activities now take on a new meaning.

Born in 1527, Dee lived under the reigns of Henry VIII, Edward VI, Queen Mary, Queen Elizabeth, and James I, and died in 1608. He was an adept in astrology and the occult sciences, and we know from his works that he had studied ciphers, a knowledge of which he considered indispensable to the student and statesman. In his early youth he was already the author of mathematical and astronomical works, and at the age of twenty-three he was the first public lecturer on Euclid. These lectures, which were given in Paris at Rheims College, attracted students, professors, and even princes, from various parts of Europe. He was constantly connected with necromancy and implicated in political plots, and to the end of his life he was under a cloud of suspicion.

Dee had no creative power nor a constructive mind and has written little that is original or of intrinsic importance, but his studies and activities were of great value. From his youth he had access to many manuscripts of the works of Roger Bacon, even to some which have not come down to us. He was absorbed in the study of these

[6] D'Israeli, *Amenities of Literature*: chapter on John Dee.

manuscripts, and his repeated efforts to promote a revival of interest in Bacon met with undoubted success. In his efforts to make Bacon's philosophy known to his contemporaries he aroused the interest of several prominent men. For example, at the Court of Elizabeth he met Francis Bacon, whose father was one of Dee's friends, and it is recorded in his *Diary* (August 11, 1582) that Francis Bacon, who at that time was only twenty-one, called on him at Mortlake. In view of Dee's enthusiasm for Roger Bacon, it is not too much to suggest that he introduced the two Bacons to each other. This at any rate provides an explanation of the origin of the remarkable influence of Roger Bacon's ideas which can be traced in the writings of Francis Bacon. This influence has been noted by many modern writers, but unfortunately it has yet to receive adequate discussion. The visit to Dee's library, in August, 1582, is particularly significant when we remember the testimony of Francis Bacon that he began to work on his *Instauration of Philosophy* in the following year, 1583, as was noticed by an American student, Miss Mary Esther Trueblood, of Mt. Holyoke College, in an article written by her, *John Dee and His 'Fruitful Preface'*.[7] This bringing together of the two great Bacons surely entitles Dee to a niche in the history of human knowledge.

In spite of Dee's zeal in reviving an interest in Roger Bacon his attitude was very strange. It was marked at times by a secretiveness which suggests that he was afraid to associate his name with that of the great heretic lest it add to the notoriety and suspicion under which he was already suffering. Sometimes in dealing with Bacon he effaces himself entirely and sometimes he suppresses the name of Bacon. In his *Diary* he describes in some detail his two visits to Louvain (1547 and 1548) for the purpose of ordering some mathematical instruments and of studying under Gogava, Frisius, and Mercator, but he does not mention that as an obvious result of his visits Gogava published in 1548 two mathematical treatises attributed to Bacon, *De Sectione Conica*[8] and *De Speculo Comburenti*.[9]

[7] *Popular Science Monthly*, Lancaster, Pa., 1910, LXXVII 236–241.

[8] In a humanistic version by Ant. Gogava Graviensis in *Cl. Ptolomaei Pelusiensis Mathematici Operis Quadripartiti in Latinum Sermonem traductio . . . Item de sectione conica, orthogona, quae parabola dicitur; deque speculo Vstorio Libelli duo hactenus desiderati*, Louvain, 1548.

[9] *Antiqui scriptoris libellus de speculo comburenti, concavitatis parabolæ* (revised version by Ant. Gogava, Louvain, 1548.)

In 1557 Dee wrote a work on Bacon, *Speculum Unitatis sive Apologia pro Fratre Bachone*, but he never ventured to publish it, and the manuscript is lost. In 1570, in the remarkable preface to the first English edition of Euclid, he speaks at length of the genius of Roger Bacon and his place in the history of science, but he avoids mentioning him except under the letters "R. B." At an uncertain date Dee copiously annotated Bacon's manuscript on the *Miracles and Art of Nature*,[10] which, however, was not published until 1618 in Hamburg, ten years after his death, and in an English translation only in 1659. It will doubtless repay students of English literature to investigate the cirumstances under which appeared the manuscript of the famous chap-book, *Fryer Bacon and Fryer Bungay*, Greene's play based on this story, and the three Bacon treatises[11] published in England during the last decade of the sixteenth century.

But sometimes Dee was talkative, especially when he was on the Continent. Swatek,[12] the Bohemian historian, records and the American chemist, Henry Carrington Bolton,[13] repeats after him that during his various visits to Prague (1584–1588), Dee talked with Emperor Rudolph for hours about the secrets and inventions of Roger Bacon. Apparently his conversations on this theme were not confined to the Emperor's presence but were heard elsewhere, for about this time the name of Roger Bacon became a token of wisdom and learning in the intellectual circles of Prague. An interesting instance of this is found in the fact that a contemporary, the great Rabbi Bezolel Loew, of Prague, famous for his cabalistic learning, was called "Der kleine Bacon."

In following the career of Dee the impression grows that Bacon's influence upon him was overwhelming. While he was still a

[10] *Epistola Fratris Rogerii Baconis de Secretis Operibus Artis et Naturæ et de Nullitate Magiæ. Opera Iohannis Dee Londinensis e pluribus exemplaribus castigata olim et alius sensum integrum restituta . . . cum notis quibusdam partim ipsius Iohannis Dee partim edentis*, Hamburg, 1618.

[11] (*a*) R. Bacon: *Libellus de retardandis Senectutis Accidentibus et de Sensibus Conservandis*, Oxford, 1590.

(*b*) R. Bacon: *Epistola fratris Rogerii Baconis de Secretis Operibus naturæ et de nullitate magiæ*, Oxford, 1594.

(*c*) R. Bacon: *Mirror of Alchimy. Also a most excellent Discourse of the admirable Force and Efficacies of Art and Nature*, London, 1597.

[12] Josef Swatek: *Obraz y z kulturnich dejin ceskych*, Prague, 1891.

[13] Henry Carrington Bolton: *The Follies of Science*, Milwaukee, 1904.

student at Cambridge, he began even to imitate Bacon's mode of life by working eighteen hours a day and sleeping only four. Much later, in 1582, in the Memorial[14] on the reformation of the calendar, presented to Queen Elizabeth, which was based on Roger Bacon's work on the subject, Dee asserted that he was a descendant of Bacon, for, he informs Her Majesty, Roger Bacon was really David Dee, of Radik, and had only assumed the name of Bacon on joining the Franciscan Order.

A careful study of Dee's *Diary* and his activities suggests that while he was at Cambridge he was already the owner of an enormous collection of Bacon manuscripts and works studied by Bacon and quoted in his writings. In a catalogue of Dee's library, prepared in 1583, just before a mob at Mortlake destroyed many of his books, believing him to be a necromancer, Dee enumerates thirty-seven works of Bacon bound in twenty-six volumes, and numerous other manuscripts, many of them undoubtedly from Bacon's library. This is a very large collection when we consider that Professor Little, the latest and best bibliographer of Bacon manuscripts, has succeeded in locating only 107 items written before the time of Dee, which number includes even fragments and single leaves.

Some of the Bacon manuscripts now on the Continent—those at Prague, Vienna, Bruges, Leyden, Wolfenbüttel, and Erfurt—were probably gifts from Dee, for he visited all these places and made friends there. Originally Dee must have had even more Bacon manuscripts, as the following information would indicate. In 1634 the Bodleian Library accepted a gift of 238 manuscripts from the celebrated physician and Rosicrucian, Sir Kenelm Digby. Among these were at least twelve Bacon manuscripts, as we learn from Professor Little, who enumerates in his catalogue twelve Bacon manuscripts containing the autograph of Digby. Digby could not have been acquainted with Dee, since he was born only in 1603, five years before Dee's death. Nevertheless the Digby Bacon manuscripts must once have belonged to Dee. In 1630, according to one authority, Digby bought, or, according to other authorities, received as a gift the entire library of Thomas Allen,

[14] *An advise or discourse about the Reformation of the vulgar Julian yeare, written by her Majesties commandement and the Lords of the Privy Council*, 1582. Unpublished. The original manuscript is in Corpus Christi College, Oxford, among the Bryan Twyne manuscripts.

of Oxford, his friend and teacher. Thomas Allen was an intimate friend and collaborator of Dee, with whom he had spent some time at the house of Henry Percy, ninth Earl of Northumberland, the so-called Wizard Earl. Here they worked together on Bacon and alchemy. Allen and Dee also intrigued as political agents of the Earl of Leicester. They are both referred to by the author of *Leicester's Commonwealth*, London, 1641, who says, "The Earl kept about him Dee and Allen, two atheists, for figuring and conjuring." Fuller says of Allen that he had succeeded to the skill and scandal of Fryer Bacon. Allen was fifteen years younger than Dee and therefore Allen's Bacon manuscripts could not have been obtained by him at the same time as that at which Dee came into possession of his; but in view of the close relations which existed between them, it is quite probable that Dee shared his manuscripts with Allen.

From these facts relating to Dee it is reasonable to conclude that it was owing to his efforts that many of Roger Bacon's works were preserved and are known to us today, and that he was the chief promoter of interest in the works of Bacon during the sixteenth and seventeenth centuries. It is also reasonable to deduce from these facts that in the collection of Bacon manuscripts, which unquestionably came into his possession as early as 1547, he found the cipher manuscript.[15] The sequence of events which suggest themselves is that, having failed to decode it, he carried the manuscript to Prague, where he parted with it as a "present" to Emperor Rudolph. He can have presented it to the Emperor only between 1584 and 1588, during which years he made several visits to Prague. He may have made this presentation either in his own name or in the name of Queen Elizabeth, on whose behalf he acted as a secret political agent at the Court of Rudolph.

Most of the Bacon manuscripts definitely known to us as having been in Dee's possession passed comparatively quickly into collections which have now become public. It is also worthy of notice that very few of the known manuscripts of the works of Roger Bacon were of the thirteenth century. Many of them were written

[15] Perhaps it is to this cipher manuscript that Dr. Arthur Dee (John Dee's son) refers in the following: Sir Thomas Browne relates in 1675 to Ashmole, "That Dr. Arthur Dee (speaking about his father's life in Prague) told about . . . book containing nothing but hieroglyphicks, which book his father bestowed much time upon, but I could not hear that he could make it out," Charlotte Fell-Smith, *John Dee*, pp. 311–312.

during the fourteenth and fifteenth centuries, and often with copious annotations, which are evidence of the existence of groups of students who during this time were working that the teachings of Roger Bacon might be transmitted to their contemporaries.

How Bacon's discoveries and ideas have filtered into the scientific literature of the fifteenth century can be shown by mentioning one or two works in point. For example, the *Imago Mundi*, 1485, of Petrus de Aliaco, made famous by the praise of Columbus, is based on Bacon's geographical work. Paulus de Middelburgo borrowed much from Bacon in connection with his treatise on the reformation of the calendar, *Paulina de recta Paschae celebratione*, Fossombrona, 1513. Few scholars,[16] however, dared acknowledge Bacon as an authority, since he had been condemned by the Church, and it was dangerous even to mention his name. Further researches in the scientific literature of the fourteenth and fifteenth centuries and the translation of the Voynich manuscript will undoubtedly show that Bacon's influence was much wider and more penetrating than is conceded today.

There remains the task of tracing the place or person from whom Dee obtained his Bacon manuscripts. The information already gathered points very strongly in the direction of the Northumberland family. The patronage of both branches of that family, the Dudleys and the Percys, is apparent thoughout the whole of Dee's life. As early as 1553, when Dee was only twenty-six years old, but already the owner of some Bacon manuscripts, he was so closely associated with the mother of the Earl of Leicester, Lady Jane, Duchess of Northumberland, that at her request he wrote two works: *The True Cause and Account of Floods and Ebbs* and *The Philosophical and Poetical Original Occasions of Configurations and Names of the Heavenly Asterismes* (unpublished). It is known that during the period of the dissolution of the monasteries in England, which began in 1538, Lady Jane's husband, John Dudley, Duke of Northumberland, amassed a large fortune by the unscrupulous pillaging of religious houses, chantries, and churches. In view of this fact, and of Dee's intimate relations with that family, it is probable that Dee profited by the Duke of Northumberland's

[16] [Mr. Voynich writes, on June 18, 1927: "While the use of Bacon's name was undoubtedly avoided, I have recently found that he is mentioned by Aliaco, Pico della Mirandola, and Paulus de Middleburgo, and therefore probably by others."—RGK]

spoils, and that his collection of Bacon manuscripts originated in this way. Further researches into the history of John Dudley, Duke of Northumberland, and of the dissolution of monasteries in England, may lead to important discoveries. It may help to locate the repository or repositories of Bacon's manuscripts; it may also disclose the names and works of his immediate pupils and of those who in the following two centuries studied him and copied and annotated his works.

To summarize, then, the history of this manuscript so far as at present can be ascertained or reasonably conjectured, we must conclude that it rested in some monastery in England, where Roger Bacon's manuscripts remained until the dissolution of the religious houses in the sixteenth century. At that time, together with other treasures from these disbanded libraries, it probably passed into the hands of one of the receivers of this spoil, the Duke of Northumberland. It was perhaps one of the manuscripts that was found in this family's possession by John Dee, who certainly early in his career obtained a collection of Bacon manuscripts.[17]

[17] [On August 1, 1927, Mr. Voynich supplied the following information: Professor James Westfall Thompson, of the Department of History of the University of Chicago, has made the discovery that a fifteenth century catalogue of the Library of St. Augustine's Abbey at Canterbury, edited by M. R. James in his *Ancient Libraries of Canterbury and Dover* (Cambridge University Press, 1903), pp. 172–406, contains seventeen Bacon manuscripts which were in St. Augustine's Library, of which twelve were given by John of London. The catalogue once belonged to John Twyne or Twine, schoolmaster and mayor of Canterbury, whose name is scribbled on it once or twice, and later belonged to John Dee. A number of Dee's books are now in the Library of Trinity College, Dublin, where the catalogue also is preserved, having been presented by Archbishop Ussher. John of London, who was a monk in St. Augustine's Abbey for many years, at least until 1331, was in all probability none other than Bacon's protégé, "the youth John." These points are set forth in Mr. James's preface to his volume. Professor Thompson writes further:

"In the bibliography appended by Dr. A. G. Little to *Roger Bacon Essays*, there is on page 393 a notice of two works of Bacon now lost. They are:

No. 14. *Tractatus expositorius enigmatum alchemiae.*
No. 15. *Treatise on Astrological Judgements.*

Bacon sent four treatises on alchemy to Clement IV. Two are in the *Opus Minus;* the fourth was found by Duhem; the third, which was sent separately by the hand of John of London, the 'youth John,' to the Pope, is lost. If sent *separately* Bacon must have attached unusual importance to it, and this may explain why it is uncatalogued in any list of his writings and is now 'lost.' But much greater interest is attached to No. 15, which also is lost. For this also was a separate treatise sent to the Pope through John, with the following enormously significant statement to His

During one of his visits to Prague, Dee undoubtedly presented it to Emperor Rudolph II, from whose possession it passed into the hands of Jacobus de Tepenecz not earlier than 1608. The manuscript then passed into the possession of a person whose name is at present unknown, who bequeathed it to Marcus Marci. It was given by Marci, in 1665 (or 1666), to Athanasius Kircher. Its subsequent history becomes again conjectural, and we may suppose that it was presented by Kircher to a patron in one of the ruling houses of Italy, after which it remained buried until it was discovered by Mr. Voynich in 1912.

Holiness: *Et si vultis copiosus videre, jubeatis Johanni ut faciat scribi de bona litera tractatum pleniorem, quam habet, pro vobis* (*Opus Tertium*, ed. Brewer, p. 270). Manifestly this work was written in cipher, of which the 'youth John' had the key and was instructed to decipher if the Pope so requested. No trace of this mysterious manuscript has ever been found, and it is at least an intriguing hypothesis that it and the Voynich Manuscript are identical.

"As I reason it out, John was sent to Rome in 1267; the Pope expressed interest, but advised young John to return to England with the manuscript and there to decipher it and make a fair copy of it and send it to him. But Clement IV died in the next year (1268); Bacon lost his patron, was in trouble with his order, kept the manuscript with him (undeciphered), and when he died left it, with other manuscripts of his, to his pupil, who took them with him to St. Augustine's, where, unlike the others, it was not listed in the Abbey catalogue, and only came to light with the dissolution of the monasteries in the sixteenth century, and finally fell into John Dee's hands, from which it passed to the continent."

This otherwise attractive hypothesis of Professor Thompson, that the Voynich Manuscript is the lost fourth of the treatises sent to Pope Clement IV, seems improbable to the Editor, for the following two reasons: (1) In the eighteen months in which Bacon prepared the four works, he would hardly have had the time to perform the enormous labor of enciphering the Voynich Manuscript, in addition to writing the other three; of the three which have been identified, the *Opus Majus*, which is the longest, alone contains about 350,000 words. (2) Newbold read in the Voynich Manuscript an account of the Comet of 1273 and an account of the Eclipse of 1290; but Pope Clement IV, to whom the four treatises were sent, died in 1268.

These objections were sent to Professor Thompson, who replied on August 10, as follows: "When I suggested the hypothesis that the Voynich Manuscript might possibly be one of the ciphered manuscripts which Bacon sent to Rome, to Clement IV, by John of London (the youth John), I did not, of course, know that Newbold had discovered an allusion to the comet of 1273 and an account of the eclipse of 1290. In view of these facts, my hypothesis becomes untenable, unless Bacon recast the Manuscript after the Pope's death, as he may have done, probably keeping it by him until his own death. As to the matter of enciphering the Manuscript, it may have been in cipher before Bacon composed the *Opus Majus* or it may have been enciphered by the youth John, who, we know, had the key."—RGK]

CHAPTER III

The Voynich Cipher Manuscript of Roger Bacon

SKETCH OF ITS CONTENTS

The Voynich Manuscript of Roger Bacon[1] is a small quarto, the leaves of which vary in size, but average about nine inches by six. They are numbered in a sixteenth century hand; the last bears the number 116, but eight leaves are missing. Several leaves are folded, thus being made equivalent to two or more, and one is a large folding sheet equivalent to six leaves. The manuscript contains at present the equivalent of 246 quarto pages; if the eight missing leaves be reckoned at two pages each it must originally have contained not less that 262 pages. The last page contains the Key only, and f.57v bears a diagram, not yet deciphered, which is probably a Key; of the remaining 244 pages, 33 contain text only, while 211 contain drawings, usually touched up with water-color, and nearly always accompanied with some text. The parchment, the ink, and the style of the drawings indicate, in the judgment of experts, England as the place and the thirteenth century as the time of origin. It is, on the whole, in an excellent state of preservation, although a few pages have suffered somewhat from abrasion.

To judge from the drawings, the contents of the manuscript fall into five divisions. The first and largest section contains the equivalent of 130 pages, 125 of which bear drawings of plants with accompanying text; this I term the botanical division. The second contains 26 pages of drawings, obviously astronomical or astrological, but of striking originality, few presenting any resemblance to the innumerable extant drawings relating to the same subjects. The drawings are accompanied by numerous legends, but little continuous text. The third section is still more strikingly original in character; it contains 4 pages of text and 28 of drawings,

[1] [This Chapter is taken from the latter portion of the lecture before the College of Physicians, pages 461–474 of the *Transactions 1921*. But some of the material on pages 464–465 has been used in Chapters X and XI.—RGK]

Plate II

Botanical Drawing, with cipher text: folio 65 verso

Courtesy of Wilfrid M. Voynich

to which no parallels of any sort are known. Some persons perhaps would term them "weird," "bizarre," "uncanny," but neither these nor any other adjectives seem to me appropriate. Yet, strange as they are, they are not lacking in artistic quality; the nude little female figures with which every page is peopled are rudely drawn indeed, but there is about them a fresh vividness, an expressiveness, which places them at a wide remove from the stiffly conventional figures of contemporary miniature painting.[2] The leading topic

[2] The contents may be summarized as follows:

	Leaves	Text	Drawings	Missing	Total
Part I. *Botanical*, ff. 1–11, 13–66	65	pp. 5	pp. 125	(f. 12) pp. 2	pp. 132
Part II. *Astronomical*, ff. 67–73, of which ff. 67, 70 (each = pp. 4) = 8 ff. 68, 72 (each = pp. 6) = 12 ff. 69, 71, 73 (each = pp. 2) = 6 pp. 26	7 ..	0	pp. 26	(f. 74) pp. 2	pp. 28
Part III. *Biological*, ff. 75–86 of which ff. 75–84 (each = pp. 2) = 20 ff. 85–86 (large sheet) = 12 pp. 32	12 ..	pp. 4	pp. 28	0	pp. 32
Part IV. *Pharmaceutical*, ff. 87–90, 93–96, 99–102 of which 87, 88, 93, 94, 96, 99, 100 (each = pp. 2) = 14 89, 90, 95, 101, 102 (each = pp. 4) = 20 pp. 34	12 ..	0	pp. 34	(ff. 91, 92, 97 98) = pp. 8	pp. 42
Part V. *Text only*, ff. 103–108, 111–116	12	pp. 24	0	(ff. 109, 110) = pp. 4	pp. 28
	108	pp. 33	pp. 213	(ff. 8) pp. 16	pp. 262

dealt with in this section is the procedure by which the soul becomes united to the body; I term it "biological." The fourth division contains on 34 pages drawings of flowers, fruits, leaves, roots, and of the receptacles used by pharmacists for their drugs; it is almost certainly pharmaceutical in character. The fifth division contains 23 pages of text, arranged in short paragraphs, each beginning with a star. The 24th page of this division, the last of the manuscript, contains the Key only.

Of these five divisions the second and the third are the most important. Their common theme is the theory of the soul, and the doctrine they teach is a very ancient one. Tradition associates it with the names of Orpheus and Pythagoras; in later times it was taught, in one or another of its many forms, by Plato and his contemporary Heraclides of Pontus, by Posidonius the Stoic, Cicero's master, and by Cicero himself, by Plutarch, by many of the Gnostics and of the neo-Platonic philosophers. Its essential feature is the astral origin of the soul. The soul dwelt originally in the stars, thence it descends to suffer temporary imprisonment in a material body. If it there obeys the laws of its being it will be emancipated by death and return to its blessed life on high. Bacon never refers to this doctrine in his printed works, but he must have been acquainted with it, for he had read Martianus Capella, Plato's *Timaeus* with Chalcidius's commentary, and other works in which it is mentioned.

In the greater number of the astral drawings the souls, represented by naked female figures, are depicted dwelling among the stars. The first drawing of the third section shows their descent to earth, and nearly all the remaining drawings of that section symbolize the physiological processes by means of which they are united to material bodies.

The first and fourth sections, dealing with the medicinal properties of plants and the methods of preparing from them drugs, and the astrological drawings, are probably connected with the preceding by their common reference to the problem of the prolongation of life, the "secret of secrets," the discovery of which Bacon seems to have regarded as the chief practical end of science. The chief influences affecting the duration of life Bacon believed to be the conditions prevailing at the time of conception, especially the health of the parents and the influence of the stars, the observance

Plate III

The Signs of the Zodiac: folio 67 recto

Courtesy of Wilfrid M. Voynich

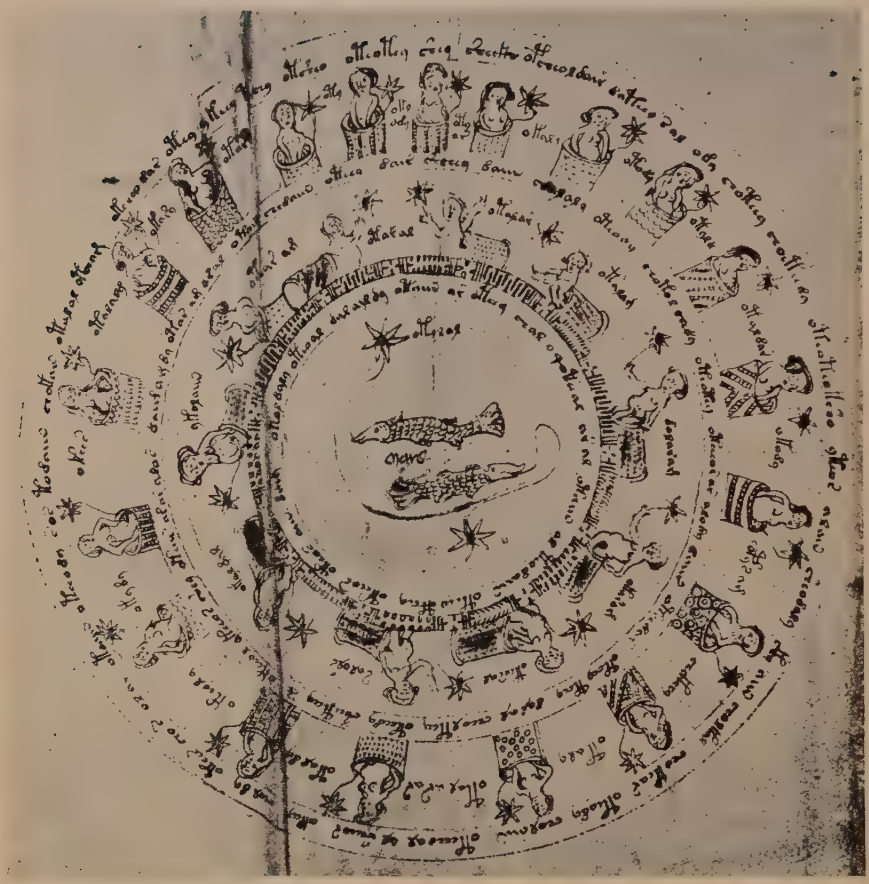


Plate IV

The Sign Pisces: folio 70 recto

Courtesy of Wilfrid M. Voynich

throughout life of the laws of hygiene and morals, and the use of the "elixir of life," as it has been called by later writers.[3]

[It is my plan now to present a few typical plates of these pages, with summary explanation.

Plate II. A botanical drawing, with accompanying text: folio 65 verso.]

Plate III. The signs of the zodiac: folio 67 recto. Female face in center, from which radiate twelve sectors, [each representing a sign, and] divided longitudinally into halves, one studded with stars [to indicate] the period during which the sign is above the horizon by night, the other painted blue and red [to indicate] the period during which the sign is above the horizon by day.

Plate IV. The sign Pisces: folio 70 recto. The Manuscript originally contained all the twelve signs of the zodiac; two are missing, but two of the [remaining] ten [which are preserved] occupy two pages each, so that twelve pages are devoted to the signs.

The drawings all follow the same general design. In the central circle is the symbol of the sign and the Latin name of the month during which the sun is in that sign. Around it are two or three concentric circular bands containing human figures, clothed or unclothed, each of which grasps a star. The stars in each drawing are those contained in the lune of the celestial sphere formed by passing great circles through the poles of the ecliptic and the boundaries of the sign in question. The figures represent the spirits dwelling in the stars; a legend is attached to each. The few that I have read give the names of the soul and that of the star, together with some characteristic circumstance. E.g., the figure in the first circle, below and left of the center [of the sign Pisces], is labelled: *Pericles occupat centrum Saturni planetae cuius Jupiter officit currui quia velocior*, "Pericles occupies the center of the planet Saturn, whose chariot Jupiter hinders because he is swifter." [Elsewhere I have read the names of] Zenobia and Cato the Censor.[4]

The barrel-like objects in which some of the souls are ensconced

[3] *Opus Majus*, II 204–213; I 387.

[4] [See Chapter XIII.]

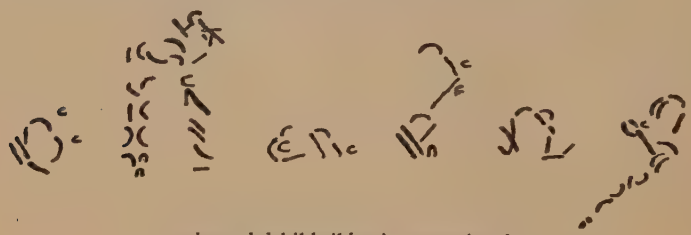
represent the body, the figure being taken from Plato's *Gorgias* (493A–494B), in which he compares the body to a "leaky cask" which the soul occupying it must continuously labor to keep full of food, drink, warmth, etc. The symbol of the body is attached to some souls in heaven probably [also] to indicate that they are not yet purified of carnal desires and are therefore still attached to their bodies on earth, [again a] Platonic [idea] (*Phaedo* 81B).

Grotesque as these figures seem to our modern eyes, one must not forget that the conception which inspired them inspired not long after Bacon's death one of the greatest poems in literature—Dante's *Divina Commedia*. For Bacon gives us here nothing other than a *Paradiso* in pictures, and we may be grateful to him for sparing us an *Inferno*. It is noteworthy also that three of the legends so far read give us the names of pagans, showing how much more liberal in religious conceptions Bacon was than his contemporaries.

Plate V. Page from the biological section: folio 78 recto. Upper corners schematized ovaries (nucleated ova); (Fallopian) tubes opened to show stream of ova descending into cavity (uterus), in which are seven souls or spirits (spermatozoa), three not yet awakened to consciousness, four expressing surprise and horror at their environment. Below, eight spermatozoa have discovered a "nest" of eight ova and view their destined dwelling places with expressions of surprise and curiosity, not unmixed with disgust.[5]

Plate VI. Another biological drawing: folio 84 recto. This is one of the most elaborate drawings in the manuscript. Above,

[5] [The legend just above and to the right of this scene I read as follows:]



uuuipqsq lplshihbtihbpeitonteupcinuuba
htcenpuq nnletequqt ouitupoiae bqonttpepttdidtt
Ut sint in sacco, rimantur pulpam de via ecstra.
Iste currat in angulos ac in sulco, ecce, ova aspicit.

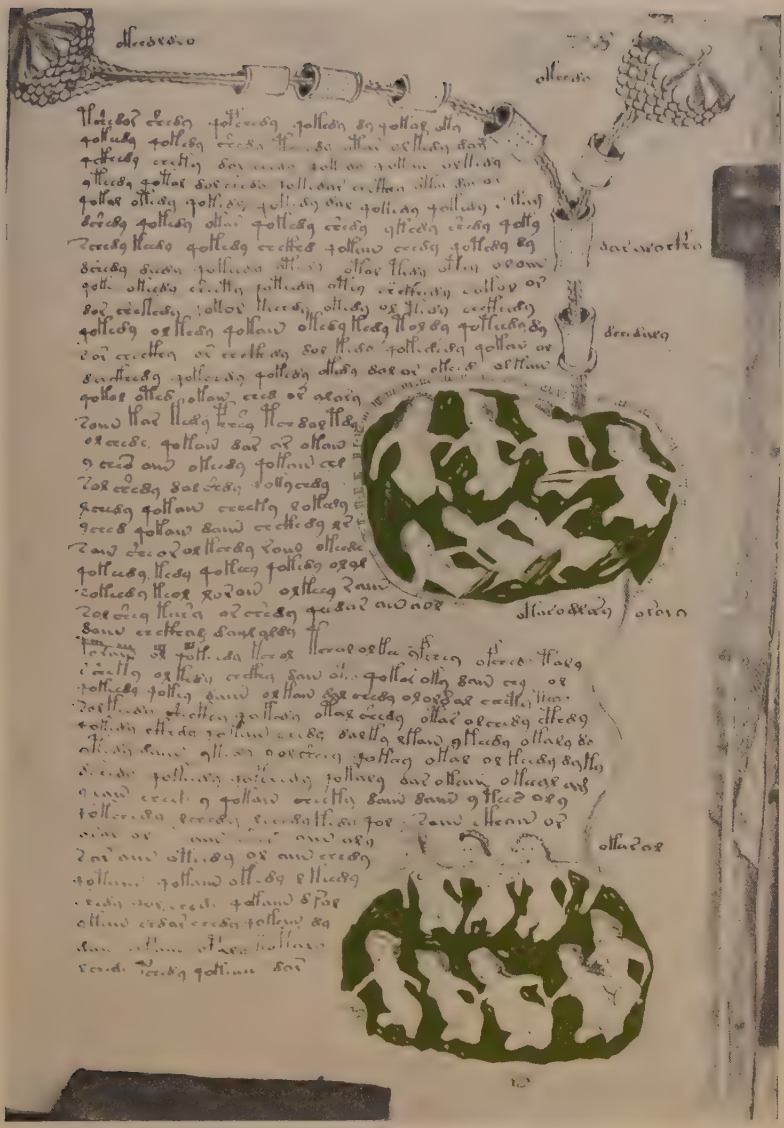


Plate V

A Biological Drawing: folio 78 recto

Courtesy of Wilfrid M. Voynich

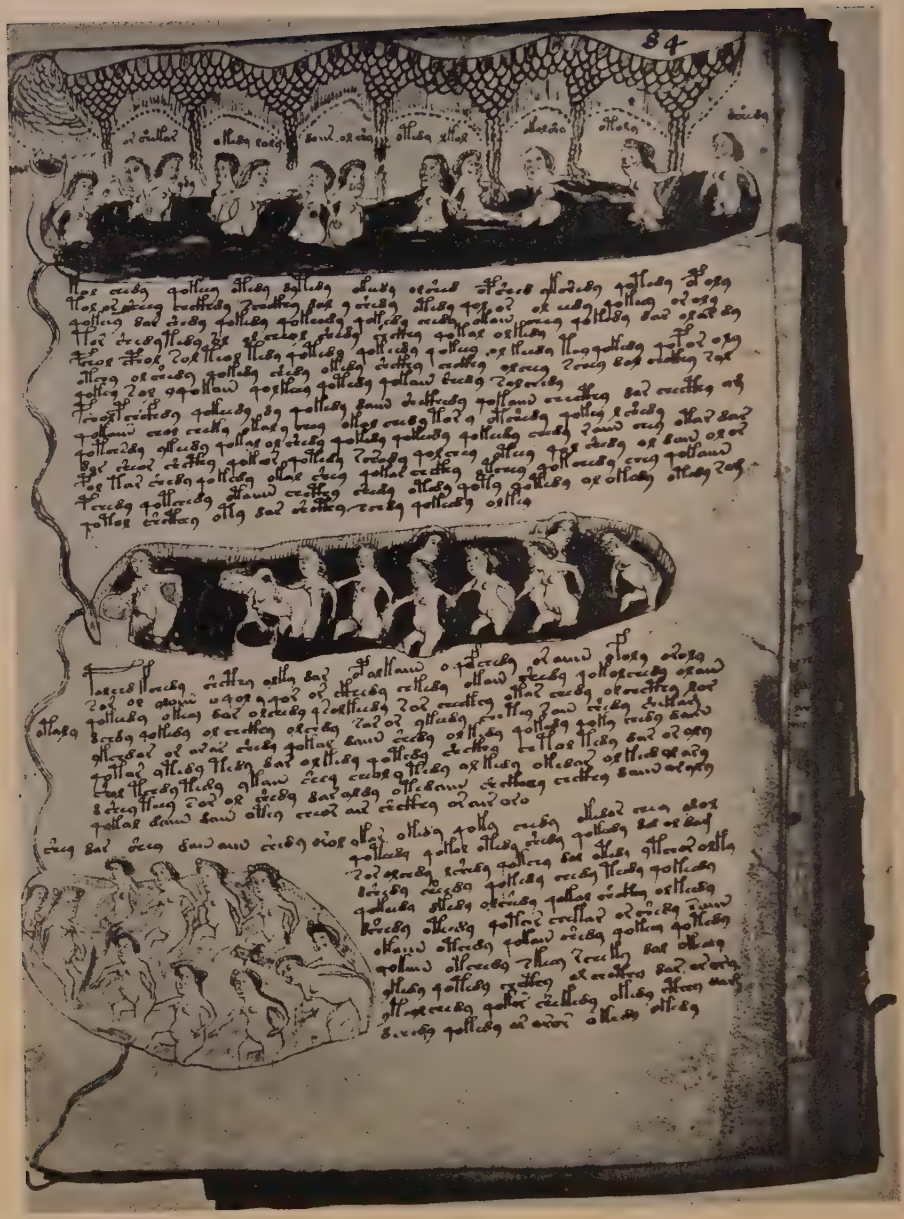


Plate VI

Another Biological Drawing: folio 84 recto

Courtesy of Wilfrid M. Voynich

the cellular structure of the testicle, the cells of which are blue and white, rains down streams of secretion into a green pool in which the life-principles produced by the gland, symbolized as usual by female figures, disport themselves. On the left margin, half disguised as an element of the design, is an obvious representation of what these little ladies actually look like under the microscope—a spermatozoön. In the middle register, to the left, a similar symbolic figure, presumably representing the soul of the female, has inserted into a cask or barrel (ovum?) a something (life-principle?) and carries another ovum under her arm. On the extreme right the spermatozoa march up in line, hand in hand, to the act of coition, the result of which is to incorporate the spiritual principle in the material body, here represented by the barrel or cask over which the female figure is stooping. The body of this figure also is given a curiously barrel-like contour, not seen in any other such figure in the manuscript, and the juncture of the neck with the body is drawn in so strange a manner that one can take the left breast as outlining an opening in the top of the barrel out of which is coming the head, neck, left arm, and a portion of a snake-like body. This is, I think, intended to symbolize the fact that the spirit introduced in the spermatozoön into the body of the female merely passes through it, so to speak, into its own body, represented by the barrel on the ground.

Plate VII. Still another biological drawing: folio 86 verso. It represents symbolically the act of coition. At the upper left corner an ovary is depicted as a roe-like mass of ova, of which the greater number have well-defined nuclei. The soul of the female which controls the functioning of the ovary is portrayed as a female figure, of which only the head and one hand are visible, throwing a mass of ova downward. The ovary in the upper right corner has discharged its ova; the dove which flies after them probably represents the brooding influence or control exerted by the soul of the mother over the seed during gestation (*Com. Nat.*, p. 281, 23–26). The scales are immature ova, the more advanced show traces of nuclei. In the two lower corners are two *membra virilia* so schematized as to avoid giving offence; the one on the left throws fine seed upward; the male figure doing likewise is the soul of the male which controls the operation. The one on the right expels three tadpole-

like objects, with heads and tails. The parallelism of the drawings puts it beyond doubt that the seed and the tadpole-like objects are alternative representations of the same thing. Bacon therefore knew that the *membrum virile* expels seed possessed of head and tail. The nesting bird attached to the tails represents the soul lodged in the seed, which Bacon compares (*Com. Nat.*, p. 278, 12) to a "son driven out of his father's house and seeking a house for himself." It will be observed that, whereas the ova are without nuclei in the earliest stage of development but have acquired them in the latest, the sperm cells are depicted as originally possessing them but as having lost them at a later stage of development.

Plate VIII. One part of a large folding sheet, folio 85–86, bearing nine drawings of circular objects, each possessed of an extraordinarily elaborate internal structure. At two opposite corners of the sheet the sun pours streams of influence (in one case represented by a stream of stars) into the adjacent disks. At the other two corners are objects resembling clock-faces without numerals, one of which pours a stream of influence into the nearest disk. These probably represent the united influences of the other heavenly bodies.

This Plate represents one of the drawings. A central oval nucleus is parted by two "blisters" from a ring of cells, which is separated by an open space containing two dotted circles from a second, outermost cell ring.

This and several other of the disks have a marked general resemblance to magnified sections of a fertilized ovum, but the resemblance in detail is not close enough to warrant identifying any one of them with any particular stage of development as seen through modern microscopes. The combination, however, of these anatomical symbols with other symbols of a different character leaves no doubt that the series as a whole is intended to symbolize Bacon's theory of the development of the ovum, especially of the influences which are brought to bear upon it. Bacon held that six factors are concerned in the generation of the organism: (1) the seed of the female, which supplies the matter, (2) the soul of the male which, operating through (3) the seed and (4) by means of the "spirits," a species of vapor or gas produced by the seed, gives form to that matter, not however without the coöperation of (5) the soul

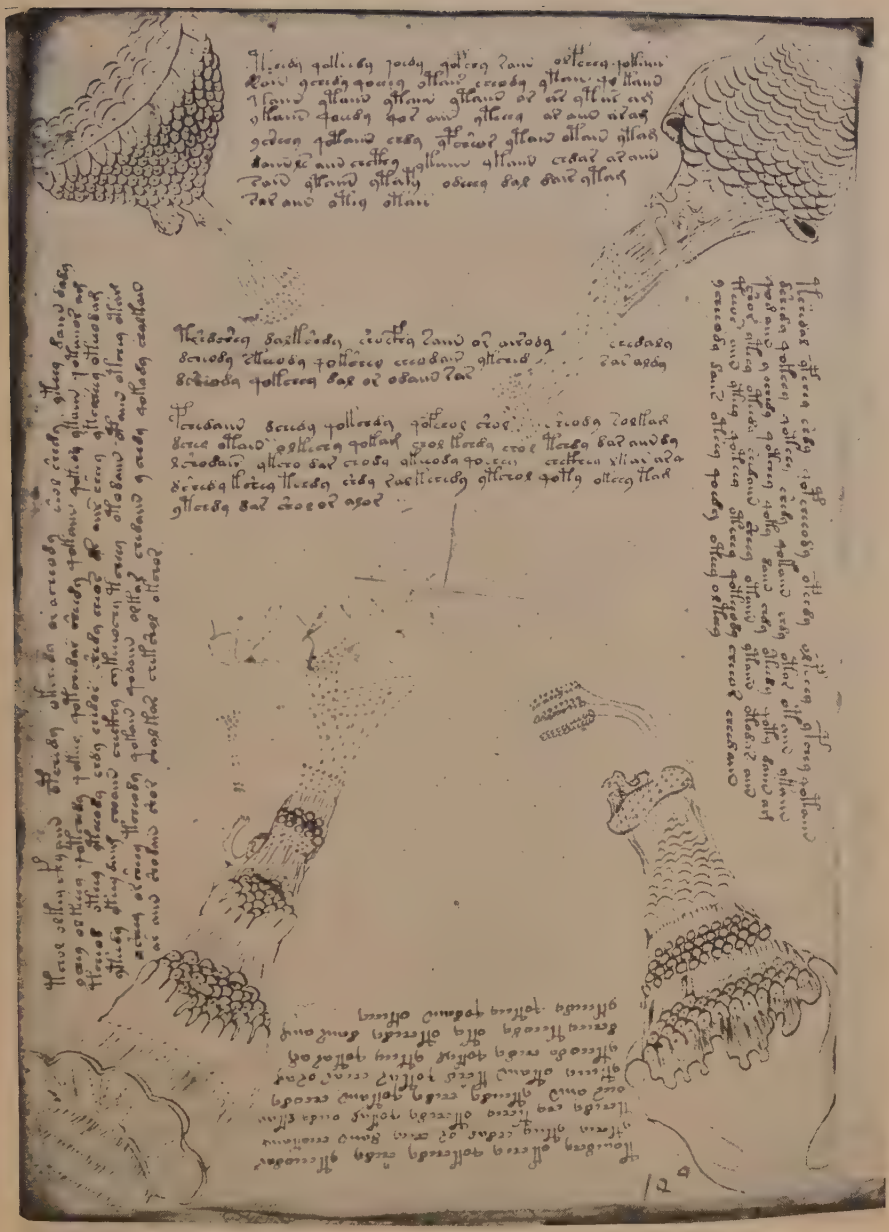


Plate VII

Another Biological Drawing: folio 86 verso

Courtesy of Wilfrid M. Voynich

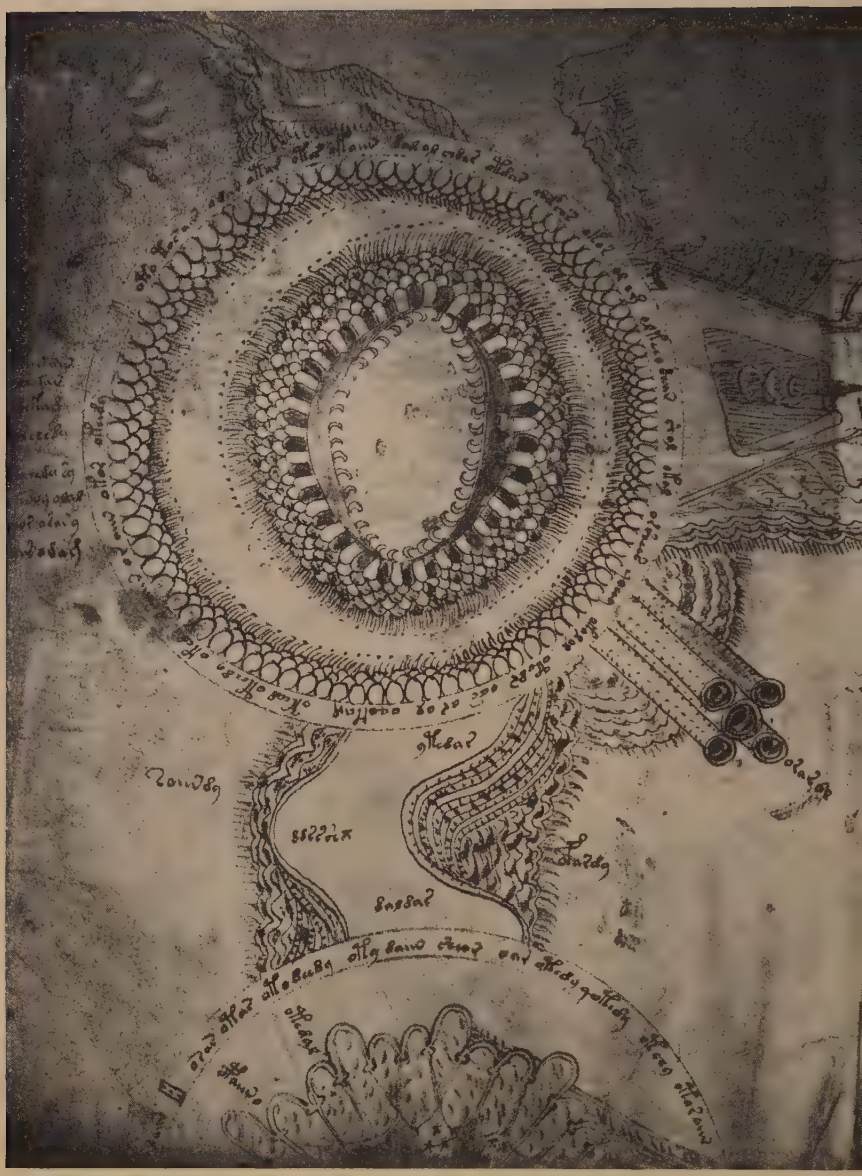


Plate VIII

The Development of the Ovum: part of folios 85–86

Courtesy of Wilfrid M. Voynich

of the female, (6) the united influence of the heavenly bodies, especially the sun, which controls the entire process. All of these factors may be recognized in the drawings. The seed of the female is represented by the cell rings in five of the disks; the male seed by an object resembling the head of a spermatozoön embedded in one of the disks (the same object occurs elsewhere in a context which requires the same interpretation); curious wave-like formations in two of the disks may well symbolize the "spirits." The celestial influence operates from the corners, its effects on the ovum is represented by masses of stars pouring into or massed within the disks, and by pictures of a church, a castle, and more modest dwellings inside one of the disks. It is also probably represented by symbols resembling those used in the astronomical section for the divisions of the sky, which are seen within two of the disks. The souls of the parents, which "excrete the seed," are not here represented but are shown on Plate VII.

Especially noteworthy is the fact that this series of drawings expresses the most striking distinction between Bacon's theory and that of Aristotle, namely, the attribution of the dominant control over the process of generation, not to the male seed but to the celestial bodies, especially to the sun.[6]

[6] Arist. *de gen. an.*, I 22, 730a19: "Among the animals that emit seed, the Nature (or active principle) in the male uses the seed as a tool and as possessing actual motion, just as tools are kept in motion while a thing is being artificially manufactured." *Op. cit.*, II 5, 741b2: "In case of animals the male of which is distinct from the female, the female cannot of herself bring what she has conceived to completion, for the male would then have had no function, and Nature produces nothing which has no function. In these animals, therefore, it is always the male that completes the generation process, for it implants the sense-consciousness, either of itself or through the semen." Aristotle nowhere attributes to the heavenly bodies any influence whatever, except that he thinks the sun's heat brings into being certain lower forms of life. Bacon's view is very different. *Opera hactenus inedita Rogeri Baconi*, ed. Robert Steele, fasc. ii, *Lib. I, Communium Naturalium*, p. 125, 3: "Hence the father is the particular cause of the child, but the sun is the universal cause. And the sun exerts his influence longer than does the father, because the father does not continue the generation until the end as does the sun, but only begins by the excretion of the seed, and the sun causes more dispositions than the father because his action is continued until the end of the process of generation, and therefore his operation is stronger, more extensive, and more violent, not only as regards the existence of the offspring but also as regards the continuation of its existence." Bacon refers to the subject very frequently; see for example, *op. cit.*, p. 276, 17; 277, 5; 280, 18–26; 281, 7–26; 303, 19–31; 308, 19–26. *Opus Majus*, I 268, 287, 379–380, 396–397; II 546.

CHAPTER IV

The Principles of Roger Bacon's Cipher

Although the cipher, or rather system of ciphers, invented and used by Bacon,[1] is notable for its complexity and difficulty, it is based upon but a few principles, as simple as they are ingenious.

It occurs in two forms. One, that used in the Voynich manuscript, I shall term the "shorthand form;" the other, the "Latin form." Either might have suggested the other, and reasons may be advanced in favor of the priority of either, but it is not possible to determine from internal evidence which was the original. For the purposes of exposition I shall assume that the Latin form was first invented, and that the shorthand form was devised later in order to evade some of the difficulties inherent in the Latin form.

Bacon's primary aim was to construct a cipher which would present no indication of being a cipher at all, and which in consequence would arouse no curiosity and prompt no one to attempt its decipherment.[2]

Take a Latin alphabet of twenty-three letters, modified by the omission of *x* and the insertion of *v*, as follows:

a b c d e f g h i k l m n o p q r s t u v y z

Combine with each letter of this alphabet, first *a*, then *b*, and so with the others down to and including *z*.

aa ab ac ad ae af ag ah ai ak al am an ao ap aq ar as at au av ay az
ba bb bc bd be bf bg . . . . . by bz
ca cb cc cd ce cf cg . . . . . cy cz

and so on to the last alphabet,

za zb zc zd ze zf zg . . . . . zy zz

One will then have twenty-three alphabets, each composed of

[1] [This Chapter was left by Newbold in virtually finished form.—RGK]

[2] [This relates to the Latin form of the cipher, used in the alchemical works.]

twenty-three pairs of letters, a total of 529 biliteral symbols. These 529 symbols constitute Bacon's chief alphabet.[3]

Since they contain all possible combinations of the 23 letters, all the pairs of letters which actually occur in the Latin language will be found among them, as well as many pairs, such as *bg*, *cz*, *zf*, which do not.

Bacon conceived the idea, an idea which was, so far as I can discover, not only original with him but also peculiar to him, never having been conceived by any later mind, of assigning to these symbols alphabetic values and [at the same time] using them to build up other Latin words. For example, using Bacon's symbols, one might write the word *tonus* thus:

```
fi-de-li-or-um
 T  O  N  U  S
```

But this method [if followed without modification] would make the upper text[4] just twice as long as the lower, for every letter of the latter would be represented by two letters in the former. To remove this disadvantage, Bacon adopted the principle that in the upper text, [of] any two consecutive pairs of letters within the same word [the former pair] must end and [the second one must] begin with the same letter. The repeated letters must then be omitted in writing the upper text. For example:

```
or-ri-it-tu-ur
 U  N  I  U  S
```

Omitting the repeated letters, one has the verb *oritur*. In reading, one must first write every *x* as *cs* and then double every letter except

[3] [When Newbold first wrote this Chapter, he still regarded Bacon's Latin alphabet as not including *k* and therefore as consisting of 22 letters. The total number of biliteral symbols was on this basis not 529, but 484, which is the number given in his interpretation of the shorthand cipher underlying the Key; see Chapter IX. Very shortly before his death, apparently, he came to the conclusion that Bacon admitted *k* to his alphabet, and therefore had an alphabet of 23 letters. It seems doubtful to the Editor that Bacon admitted the three interchangeable letters *c k q* on even terms, and the values found in the Tables of Chapter XX strengthen his doubts; see also the preliminary remarks to Table VI.—RGK]

[4] [The "upper text" is the obvious or superficial text, while the "lower text" is the true or concealed text which can be reached only by decipherment.]

the first and the last of each word. The word *exitum*, for example, must be taken as:

```
ec-cs-si-it-tu-um
 I  L  L  I  U  S
```

But in practice it is wasteful of time and effort actually to write out the doubled letters as I have done above. It is more convenient to place the cipher equivalent of the first pair under the second letter, that of the second pair under the third letter, and so on, thus:

```
ut pro ponte in via
 E  CS  CUSA  T  AM = excusatam
```

A considerable number of individual Latin words may be written by Bacon's cipher in the way which has been illustrated, and occasionally it would be possible even to write two or more words in proper grammatical relation and making coherent sense both in the upper and in the lower text, as in the last illustration. But it is quite impossible to write a continuous text of any length in which both the upper text and the lower text make good sense. The words and consequently the sequence of letters in the two texts are determined by entirely independent factors, and the twenty-three equivalents which the cipher provides for each letter of the alphabet do not offer a range of choice sufficient to fit the lower text directly to the upper text.

In order to meet this difficulty, Bacon assigned to many of his symbols two, three, four, or [occasionally] even more values. In the illustrations I have as yet given but one value for each symbol, but in fact many of them have more than one. They ought to be written as follows:

```
oritur     ecsitum     ut pro ponte in via
 UNIUS      ILLIUS      E  CS  CUSA  T  AM
 ARCCC       U CCU      S   E   S M     RR
  EUAP         UA       I   I            CI
                        N                N
                                         E
```

In only one of these words do the multiple values obscure the

word intended: UNIUS may also be read UNCUS, but it is clear that if the word occurred in a continuous text the context would determine which word should be read.[5]

While this device supplied Bacon with a very large number of additional values, he still had not enough for his needs and therefore introduced another of an even more radical character. He reduced the 23 letters of the ordinary alphabet to eleven on purely phonetic principles, and thus at one stroke approximately doubled his total number of symbols [available for representing each individual letter]. Four letters only, of this [new] alphabet, have but a single sound, *a*, *e*, *m*, *n*. Of the vowels, *i* and *y* [are regarded as a single letter, and] *o* and *u* are regarded as a single letter; [*v* is not distinct from *u* any more than *j* is distinct from *i*]. Of the consonants, the labials *p f b* are taken as one letter; so also the dentals *t d*; the gutturals *c g k q*; the liquids *l r*; and the sibilants *s z*.[6] The letter *h* is omitted except in the words *mihi* and *nihil*, which are written *mici* and *nicil*.[7] Instead of *x*, *cs* is used invariably. Thus the phonetic alphabet comprises the following eleven letters:

a b-f-p c-g-k-q t-d e i-j-y l-r m n o-u-v s-z

The extent to which this principle enlarges Bacon's range of choice may be shown by applying it to the examples already given:

[5] [In fairness, one must point out that by application of the principle in the next paragraph of Newbold's text, *oritur* might stand also for *alius*, *alios*, *arcus*, *uncos*, and that *ecsitum* might stand for *Julius*, *Julios*, *Julias*. Yet as Newbold says, the context would normally remove the ambiguity.—RGK]

[6] [The phonetic basis for this simplification is given by Bacon himself in his *Oxford Greek Grammar*, pp. 48 ff. One might note that in the early Greek inscriptions of Cyprus, a similar simplification of the labials, dentals, and gutturals to one of each class took place; the writing was by a syllabary, in which *ta* represented *τα δα θα*, *pa* represented *πα βα φα*, *ka* represented *κα γα χα*, while *te ti to tu*, *pe pi po pu*, *ke ki ko ku* represented the other combinations. As to the amount of ambiguity produced in Latin by this simplification, see Appendix to Chapter VI.—RGK]

[7] [These are merely the late spellings *michi* and *nichil*, with omission of *h*. These are the only Latin words in which the intervocalic *h* was of real importance; therefore, after *h* was no longer sounded, it was here graphically strengthened for its preservation, a fact which is represented in the pronunciation of these two words by French and Italian scholars to-day. Such an overdoing of the matter is not unlike the cockney addition of *h* in English words where it does not belong.]

oritur	ecsitum	ut pro ponte in via				
UNIUS	ILLIUS	E	CS	CUSA	T	AM
ORJOZ	JRRJOZ	S	GZ	GOZM	D	RR
VLYVC	YU YVU	Z	KE	KV		LL
AECCG	V CCO	I	QI	QS		CI
GGK	O GGV	J	J	Z		GJ
KKQ	KK	Y	Y			KY
QQP	QQ	N				Q
UAB	UA					N
O F	O					E
V	V					

Although the use of the phonetic alphabet often makes the reading ambiguous, the adjacent letters, in case of a single word, or the context in continuous text, usually determine the word with little room for doubt. For example:

ecsitium
IRRITES
cpcu
umt
m
n

IRRITES strikes the eye at once; it is a familiar Latin word and there can be little doubt that one should read RR and not LL. But IRRIDES is quite as good a word, since *ti* signifies T and D indifferently, and there is nothing in the letter-group to decide between them.[8] The context however would probably settle the question.

Among the above examples, *oritur* is the only one that presents any real ambiguity; it may be read ARCUS as well as UNIUS or UNCUS.[9] Here again the context would have to determine which reading should be adopted. If it failed to do so, I would prefer UNIUS because *or* is more frequently used for U than for A, and *it* is a common symbol for I and U, while one seldom finds it used for C.

In working, I do not write out the various equivalents of the several phonetic letters. I use a simplified form of the alphabet:

a p c t e i r m n u s

[8] [Other possibilities, overlooked by Newbold, are ILLIDES and ILLUDES. Considerations of syntax would decide for or against IRRIDEO.—RGK]

[9] [But see Note 5 of this Chapter.—RGK]

But in copying the translation in final form, I substitute, when needful, the letters ordinarily used.[10] [From this point onward, therefore, to avoid cumbersome groups of letters, the letters of this simplified form will be quoted without the addition of the several values: C will mean C G K Q, R will equal R L, and so on.]

It is not possible, at present, to determine the precise number of equivalents for each letter of his phonetic alphabet which Bacon acquired by these various devices. While the theoretical values may be ascertained by the laws of the cipher, to be explained in Chapter VI, not all of them have been proved by experience actually to occur in use,[11] and not all of the laws which I have formulated have been sufficiently tested to be put beyond question. Nor is it possible to enumerate all the symbols occurring in the Latin language or in foreign words which Bacon could introduce into his text. Mediaeval Latin abounded in words derived from Greek, from Arabic, and from the vernacular languages of Europe; and in some of these words, phonetic combinations occur which are not to be found in Latin. The figures given in the following table are therefore not final, but they are not far from correct:[12]

Phonetic Letter	Total Number of Symbols Having this Value	Number of Phonetically Possible Symbols Having this Value
A (= a)	78	47
P (= b f p)	39	29
C (= c g k q)	125	84
T (= d t)	65	39
E (= e)	116	82
I (= i j y)	106	64
R (= l r)	143	89
M (= m)	130	82
N (= n)	92	63
U (= o u v)	132	73
S (= s z)	73	56

[10] [That is, in the working sheets, of which a sample is given at the end of Chapter VIII. The Editor has conformed strictly to the simplified alphabet in the presentation of the processes, as on p. 115, where U and C of the mere transliteration become *o* and *g* in *Rogerus*.—RGK]

[11] [Cf. the preliminary remarks to Tables VI and VII, Chapter XX.]

[12] [This Table has been extensively revised by the Editor; so also has the succeeding paragraph, though the main points made in it remain the same.—RGK]

It will be observed that eight of the eleven letters have, [while not even] approximately the same number of available equivalents, [still a very large number,] running from 56 to 84; two, T and P, have only [a trifle more than] half as many, 29 and 39 respectively, and A has but 47. This discrepancy is partly compensated by the fact that among the symbols which signify these three letters there are some found very frequently in Latin. The case-ending *-em* signifies T; so also do the prepositions *ab* and *in*, the *qu-* of the relatives, and the *cu-* of *cum*. Among the symbols for A are the word-endings *-ne*, *-pe*, *-pi*, *-ta*, *-te*, the *-vi* [found in the perfect of verbs, and also] equivalent to the *ui* of the relatives, and the preposition *ad*. But P has only two symbols of frequent occurrence, the case ending *-us* and the syllable *-ti-* which is seen so often in verbs of the third and fourth conjugations, and in nouns with the stem *-tion-*.[13]

Notwithstanding this imposing array of equivalents, Bacon found that he was still unable to write the two texts consecutively and make sense of both. He therefore adopted two other devices.

The first consisted in transposing to a certain extent the letters of the lower text, leaving however a sufficient number of letters grouped together to enable the reader to recognize the word intended. Take for example a sentence from Bacon's cipher work, *The Abbreviated Word of Brother Raymund about the Green Lion*.[14] I write the cipher text on the upper line in italics, placing the equivalents under the second letter of the symbol to which they belong according to the system already adopted. The equivalents are written in the abbreviated phonetic alphabet [of eleven letters, just explained,] until their actual values are fixed. The letters belonging to the word expressed by each group are in capitals; superfluous letters, which are to be carried down to the next group, are in minuscules. I begin with the fifth symbol of the cipher word *abbreviavi*. The letter S remains over from the preceding group and therefore heads the line.

[13] [To this should be added, as values for P, the common groups *vr*, equal to the *-ur* in passive endings; *pe*, *pl*, *pt*, *sp*, *st*, *to*. The statement in the text is therefore not quite fair.—RGK]

[14] [*Verbum Abbreviatum de Leone Viridi*, printed in 1603 at Frankfurt, pp. 264–285 of *Sanioris Medicinae* etc.; cf. Little, *Roger Bacon*, p. 397, No. 21. Newbold used also a photostat of the Bodleian manuscript Digby 119.—RGK]

```
  -ev-
S  C    SIC
   i
```

The symbol *ev* has the values both of I and of C.[15] One could read the group therefore in three ways, SI and *SIC* and SI*C*, [where I am] using italics to indicate omitted letters; [that is, letters not yet found by decipherment, and so to be looked for later.] The only way to determine which [of the three] is intended is to proceed with the translation until the sense makes evident which word is to be chosen. The missing *I* must be supplied from some later group.

```
-viav-
 ARS    ARS
 rmt
 ci
```

There is no difficulty in recognizing this word at a glance.

```
-vi vobis in opere lu-
 A  SNRI  T  pAiL  U    NATURALIS
 n  cem      npte  s
      ru       e
```

The letters of this word are much confused, but the groups NRI and NLI are common abbreviations for *naturalis* in mediaeval manuscripts and would certainly have suggested the word at a glance to any mediaeval scholar, as they did in fact suggest it to me at the first glance. The unused letters, *p-n* and *i-t*, must now be carried down to the head of the next group.

```
    -unae et solis. Inp-
P I  CSR  I  ipni   TC     PICTRICS
n t  pmm  r  nae     e

    -primis
P N I GnuTI                PINGIT
a e   emm
        rr
```

The two letters brought down from the preceding group, combined with the first letter of the new group, give the syllables *pic-*, *fic-*, *nic-*. The last does not readily combine with the following letters, but the other two do: one can readily make the words *pictrix* 'painter,' *fictrix* 'moulder,' *pictilis* 'embroidered,' *fictilis* 'made of clay.' The first two can be taken with *ars naturalis*, the "art" residing in natural objects; the only question is, which would be preferable?

The *i-n* which is the value of *so* in *solis* is not carried down to the

[15] [It must be borne in mind that *ev* and *eu* are identical, and that *ev* has the value of *eu* as well, while *eu* has the value of *ev* also. This is true of all symbols containing *u* or *v*.—RGK]

next group as a remainder, because it is taken to supply the *i* omitted in the first word *sic*. This I have indicated by putting it in italics.

The next word does not throw any light on the question [of *pictrix* or *fictrix*], for it can be read either *pingit* or *fingit*. The group might be read also *pingunt* or *fingunt*, but since the subject, *ars*, is in the singular, the verb also must be in the singular. One must therefore look to the author's general sphere of ideas. Now, in the Aristotelian-scholastic philosophy, the "art" or purposive energy which resides in natural objects was habitually conceived as a shaping, moulding power which confers upon natural objects their forms, while it was but seldom conceived as merely "painting" their exteriors. So when I first read these words I took them as *fictrix fingit*.

```
   oppi-
N O  pVA          NOVA
e m  nsr
  r

 -ido flagitans
P  EE  iNMsOAsN   PhENOMENA
n   i  aer i m
```

The next word, *nova*, is very obvious, and the last, *phenomena*,[16] seems to me not less so. At all events, the first syllable *pe* or *fe* combines so readily with the following letters that they combined in my mind instantly. It was this last word which led me to change the *fictrix fingit* into *pictrix pingit*. The "moulding" power of nature does not merely paint the exterior surface of things, it makes them what they really are; but *phenomena* refers to the external appearance only. I think the passage should be read, "Thus the art of nature like a painter makes new presentations of sense." And this reading agrees with the context.[17] But I do not regard the other reading as excluded.

This passage will serve as a preliminary illustration of the way in which the letter-groups, the grammatical construction, and the sense of the passage as a whole cooperate in determining which word a given letter-group is intended to represent. Of the three, the letter-group is of chief importance. Bacon always takes especial pains to make his words clear at the beginning of a treatise

[16] [Newbold regarded Bacon as writing normally in classical Latin, and therefore as using *ae* rather than *e*. But he is not always consistent in his decipherment, as here, where he writes *phenomena* instead of *phaenomena*. Probably he would have granted Bacon a certain latitude in his orthography.—RGK]

[17] [See Chapter XIX.]

or of a paragraph, when the reader has no knowledge or only vague knowledge of what he intends to write about, and also when he uses uncommon words, especially Greek words or proper names. But in writing of familiar subjects, when the coming ideas are, or ought to be, already arising in the reader's mind, and especially in the use of more or less stereotyped phrases, he frequently permits the letters of the under text to become so jumbled together that the group gives no suggestion whatever of its meaning; the meaning must be supplied from the context alone.[18] A good illustration will be found on page ■.[19]

It will be seen therefore that the reading of the Bacon cipher presupposes considerable equipment on the part of the reader. A good knowledge of Latin is essential, but it is not sufficient. One must also be familiar with mediaeval thought in order to be able to catch, from the indications given by a few words, the theme with which he is dealing, and to enter at once into the sphere of ideas associated with that theme. It is also desirable, if not absolutely necessary, that the reader be acquainted with the method of writing Latin customary in Bacon's age. A mediaeval scholar seldom saw a Latin text written out in full. In virtually all manuscripts the majority of the words are abbreviated, often represented by only a few of the letters which properly belong to them, supplemented by a complicated system of abbreviation symbols which are often by no means free from ambiguity. An example, which I have taken from a Vatican manuscript of Bacon's *Perspectiva*,[20] may be of interest to those who have not had occasion to read mediaeval manuscripts. Letters omitted in the manuscript but indicated by a mark of abbreviation are represented by dots; if the mark itself distinctly suggests the omitted letters they are inserted in italics. Bridges' text, [spelled out in full,] is placed on the line below.

[18] [That is, of course, within the limits permitted by the stock of letters to be rearranged into words, a factor which presents at times the most unexpected difficulties when one allows his own preconceived notions of what the text ought to be, to be his main guide in its reconstruction.—RGK]

[19] [This is not to be found in Newbold's papers, and the Editor hesitates to select an example for this purpose.—RGK]

[20] The manuscript is Vat. Lat. 3102, [folio 27r, shown in Plate XXVII; the text quoted begins with the fifteenth line from the bottom of the first column. It] is printed in Bridges, *Op. Maj.* II 164.

De visione fracta maiora s..t Na. de facili p..*et* p*er* canones
De visione fracta majora sunt; nam de facili patet per canones

supr.d.c.os q*uod* maxima pos...t apparere m...ma & e*con*..a & l..ge
supradictos, quod maxima possunt apparere minima, et e contra, et longe

distan..a videbu.t.*r* p*r*opi.q..ssime & e*con*..a Na. possum*us* sic
distantia videbuntur propinquissime et e converso. Nam possumus sic

fig.*r*are p*er*spicua & tali..r ea ordi.ari r.....v n...ri visus
figurare perspicua, et taliter ea ordinare respectu nostri visus

& re*rum* q*uod* f*r*.nge.t.*r* radii q.*orumcunque* volu.*r*im*us* & ut s.b
et rerum quod frangentur radii quorsumcunque voluerimus, ut sub

q.o*cunque* ang.lo volu.*r*im*us* re. p*r*ope *ve*l longe & sic
quocunque angulo voluerimus videbimus rem prope vel longe. Et sic

ex inc*re*dib.li dist....a legem*us* litt*er*as minutissi.as & pulu*er*es ac
ex incredibili distantia legemus literas minutissimas et pulveres ac

harenas num.*r*arem*us* p..p..*r* mag.*i*tudi.em a.g.li s.b q.o vid*er*.m*us* &
arenas numeraremus propter magnitudinem anguli sub quo videremus, et

max..a corp*or*a de p*r*ope vix vid.*r*.m*us* p..p.*er* p*ar*vitate. ang.li s.b
maxima corpora de prope vix videremus propter parvitatem anguli sub

quo vid*er*.m*us* Na. dista.cia n.. facit ad h.i*us*.... visiones n..i
quo videremus, nam distantia non facit ad hujusmodi visiones nisi

p*er* acc...ns s*ed* q.*a*.titas ang.li
per accidens, sed quantitas anguli.[21]

A mediaeval scholar, accustomed to read his Latin in this abbreviated form, would have much less difficulty in recognizing Bacon's word groups than we have. Experience has shown me that many excellent Latin scholars who have not had occasion to acquire that skill, find it difficult or impossible to see them at all, and in consequence can make nothing of Bacon's cipher text.

[The second of the two points is that] finding all these numerous devices for increasing the flexibility of his system insufficient for his aim, Bacon is often compelled to adapt one of his texts to the

[21] [Of 584 letters in this passage, not counting the word *videbimus* omitted in the manuscript, there are 207 letters, or over 35 per cent, which are indicated by abbreviations or are omitted.]

demands of the other; and, since the upper text must be free from anything which could awaken the suspicion of the casual reader, the lower text usually, with some exceptions presently to be explained, is the one to suffer. The device may be explained in a very few words: small words, and occasionally larger ones, are sometimes displaced, the words are not always well chosen, and the syntax is often awkward.

The most conspicuous exception is the use of alchemical jargon. In order to free himself of the constraint of the upper text Bacon abandoned the attempt to give it any coherent sense and wrote blank nonsense, and in order to conceal from the ordinary reader the fact that it was nonsense, he professed to be relating the secrets of alchemy. A more audacious and a more successful hoax has probably never been perpetrated upon a gullible public. In the thirteenth century, alchemy, the predecessor of modern chemistry, was believed to be closely related to, if not identical with, black magic; its practicioners were viewed with suspicion and fear and were never free from the danger of persecution. Many an alchemist was own brother to the modern counterfeiter, and the "gold" which he manufactured did not deceive him so thoroughly as it did the recipients of the coins which he made out of it. But many were sincere students of nature, pioneers exploring a vast and unknown region, with almost no equipment in the form of apparatus, and guided, or rather misled, by quite erroneous theories. Yet they frequently discovered new reactions, leading to the formation of new chemical substances, and sometimes their discoveries were of real importance. It was probably during Bacon's lifetime that alcohol and gunpowder were discovered; at all events it was at this time that they first became known to European students. In order to record their discoveries and at the same time to guard against their becoming known to anyone except their brother practicioners of the craft, the alchemists had devised a technical terminology, quite unintelligible to the uninitiated, in which all the more important substances, apparatus, and processes of the alchemist are designated by fanciful terms. The late Professor Pierre Duhem of Bordeaux discovered in the National Library of France an unknown work of Bacon,[22] in which Bacon gives, for the benefit of Pope

[22] *Un Fragment Inédit de l'Opus Tertium de Roger Bacon*, Quaracchi, 1909. [The examples are taken from] pp. 184–187.

Clement IV, a brief lexicon of alchemical terms. From this I take a few illustrations:

Bodies, substances which do not evaporate.

Spirits, substances which do evaporate.

Planets, metals: *Saturn*, lead; *Jupiter*, tin; *Mars*, iron; *Sun*, gold; *Venus*, copper; *Mercury*, living silver, i. e., our "quick" silver.

Other names for gold are *the stone*, *the body from the river Ebro* or *from the Pactolus* or *from the Tagus*, *the Irish body*, *the Irish stone*. For silver: *pearl*, *mother-of-pearl*, *England*. Pale gold also is called *England*, and yellow gold [is called] *Spain* or *Apulia* or *Poland*.

To make red or *white* means making gold or silver.

A medicine or *a laxative medicine* is a substance which converts one metal into another; it is also termed *an elixir*.

The greater work is the making of gold; *the lesser work* is the making of silver. But *the lesser work* also means the process by which a pound of *medicine* converts from ten to one hundred pounds of a base metal into a nobler one, and *the greater work* that by which it converts a still larger amount. *The greater work* also signifies the process of extracting a *medicine* from animal substances, *the lesser* that of extracting it from inorganic substances.

A stone is any substance used in or prepared by alchemy, but especially it signifies *the Elixir*, which converts base metals into more noble ones.

The four elements, earth, water, air, and fire, are termed *the four spirits*, *the four humors; East*, *West*, *North*, *South; Spring*, *Summer*, *Autumn*, *Winter*.

Another characteristic of the alchemical technical language is its curious intermixture of extravagant pretensions with ostentatious piety. The alchemist desired to inspire others with respect for himself and his art, and he also desired to defend himself against the frequently repeated accusation of being in league with the devil; hence he usually interlards his exposition with extraordinary claims as to the importance of the secrets which he is communicating or which he could communicate if he would, and with pious invocations to God (often copied from his Arabic sources) and to Christ, the Virgin Mary, and the saints.

Bacon knew well the vanity and the gullibility of the average man. He probably reasoned that he ran little risk of detection if he wrote nonsense in alchemical jargon; no one except professional alchemists would understand enough of it to know whether it made sense or not, and any professed alchemist would be slow to admit that a brother craftsman had written something too profound for him to understand. If consulted, he would be more likely to assume a look of owlish wisdom and pronounce these secrets of Brother Roger to be of such weighty import that he could not take

upon himself the responsibility of communicating them to an outsider. To Bacon, himself an absolutely sincere seeker after truth, the pretense and cant of these alchemists seemed contemptible, and he felt himself justified in taking upon them a revenge of which the grim yet whimsical humor is unparalleled in the history of science. He made the upper text of his cipher documents professed treatises upon alchemical subjects, usually expositions of the art of making the famous "Elixir" which would prolong human life indefinitely and convert the base metals into gold. In style they are delightful parodies in which the bombast and cant of the alchemists are caricatured with inimitable skill, but in substance they are for the most part sheer nonsense. I do not think that they are all nonsense; that would not have been necessary for the attainment of Bacon's end and would have increased the risk of detection. How much makes sense, is a question which only chemists can answer; as I am myself almost entirely ignorant of chemistry, I do not know how many of the reactions which Bacon describes would actually take place if the experiments were performed in accordance with the instructions given. But it is obvious to any one that in many cases the very instructions themselves are nonsense; they are so vague or so self-contradictory that they tell nothing as to what is to be done.

A few examples of these cipher texts, [that is, of translations of the upper texts,] will give a better idea of their character than any amount of description.

"Here begins the secret of the secrets of nature about the praise of the philosophers' stone. The secret of the secrets of nature: let the secret ones hear the thing I am saying and the beloved ones the words of my mouth. The spirit blows where he will, therefore let that person be set afire into the pit of penitence who shall reveal this great secret to a rascal or a fool. For this is the ultimate secret, which the ancients sought and could not find; they examined and failed, although examining with examination. For this secret is a heavenly gift, destined in vegetables for us unworthy ones, which neither the doctors knew nor the philosophers perceived, but we moderns by grace divine have it by experience and know the efficacy of a thing so great that neither can any one living think it out nor voice worthy of the gift explain its wealth of virtues. And therefore into the pit of penitence let him fall who to a rascal or a fool

reveals it. In the name of God therefore receive this heavenly gift and extract from it the elements in the way you know and keep well every element from the air," and so on.[23] He tells no more as to what the "heavenly gift" is.

I next take instructions for the performance of a chemical experiment, from the *Three Words*:[24]

"Now to our object! Every composite consists of four inferior things. Let us put lead or anything we please into a retort, in such wise namely that the more ponderous the body, the lower down will be the still. Comprehend: put in that instrument, and let the glass be well closed with the cement of the mastery. Now in there are four things. First you distill clear water, then air and fire together, etc. Some say that in the first distillation we can have three distinct things," and so on. It will be of interest to the modern chemist that you can distill clear water out of "lead or anything you please."

One more example of the precision with which Bacon lays down the conditions prerequisite to the success of a chemical experiment must suffice. It is taken from his *Letter on the Secret Works of Art and the Nullity of Magic*:[25]

"When six hundred and two years of the Arabs had passed, you asked me about certain secrets. Take therefore the stone[26] and calcine it with gentle roasting and hard rubbing, or with sharp things. But in the end mix it with a little of sweet water, and compound a laxative medicine of seven things, if you please, or of six or of five or of as many as you please; but my mind rests in two things of which the better proportion is in the proportion of three to two" (another manuscript has "of which the proportion because it will be softer in six than in another proportion;" this makes no sense, but may be the original text of which the other is

[23] [The opening sentences of the *Secretum secretorum naturae de laude lapidis philosophorum*, printed 1603 at Frankfurt, pp. 285–291 of *Sanioris Medicinae* etc. See Little, *Roger Bacon Essays*, p. 413, No. 54.—RGK]

[24] P. 294. [*Tractatus Trium Verborum*, pp. 292–387 of *Sanioris Medicinae* etc., Frankfurt, 1603; cf. Little, *Roger Bacon Essays*, pp. 398–399, No. 22.]

[25] Brewer, *Opera Inedita*, pp. 548–549. [The Latin text is given in Chapter XIV, with the decipherment.]

[26] ["The stone" and "a laxative medicine" are to be understood in the technical sense of the alchemical jargon, as explained on page 64.]

some scribe's emendation[27]) "or thereabouts, just as experience can teach you. However resolve gold at the fire and heat it rather soft. But if you would believe me you would take one thing, this is a secret of secrets and a mighty miracle of nature. To it therefore, mixed out of two things or out of more or out of the Phoenix, which is a singular animal, adjoin[28] and incorporate by strong motion, to which if hot water be added four or five times you will have your final object. But afterwards the heavenly nature is weakened if you pour in hot water three or four times."

It would seem incredible that such nonsense as this should have passed unchallenged for more than six hundred years as the serious, scientific work of such a man as Roger Bacon was acknowedged to be. And yet it did. The number of manuscripts of these cipher works still surviving proves that, during the three hundred years that elapsed between Bacon's death and the invention of printing, many persons were studying and copying them. With the exception of the *Letter* they have only once been printed; and their unintelligibility is no doubt the reason why they were never reprinted, why the original edition has become so extremely rare, and why they are so generally neglected by students of Bacon. But there seems to have been at least one anonymous scribe who was initiated into the secret. On the margin of a manuscript seen by Brewer of the *Letter* is the note, *Haec sunt aenigmata*.[29] Now *aenigma* may mean nothing more than the technical language of alchemy (it is used in that sense by Bacon), but since it is obvious that the text is written in that terminology, I think it likely that the unknown scribe meant to say that the text is written in cipher. No one else seems to have suspected it until the late Lieutenant-Colonel H. W. L. Hime undertook the study of these works. His thorough knowledge of alchemy enabled him to detect the fact that they consist of nonsense, and he inferred, speaking of the *Letter*, Chapters 9–11:[30]

"Now, it is past belief that a man of commanding genius should

[27] [Newbold adopted this more meaningless variant, as well as some others, as the text to be used in decipherment.—RGK]

[28] [Reading *adiunge*, with Brewer; but *ad ignem*, with the manuscript, for decipherment.]

[29] Brewer, *Op. Ined.*, p. 545 note.

[30] *Roger Bacon and Gunpowder*, in Little, *Roger Bacon*, [pp. 320–335, especially pp. 330–331.]

have deliberately stooped to write page after page of nonsense. The three chapters, therefore, must have *some* meaning, hidden from us though it be."

Colonel Hime attempts to decipher the text, but quite naturally without success, since he has no clew to its real character.

In three known documents Bacon introduces obvious cipher passages into the upper text, which is itself cipher also.[31] He did it for several reasons. The chief underlying motive is to be found in the difficulties which he encountered in adapting the two texts one to the other. These difficulties are most formidable at the end of a document. As one approaches the end, the number of words which may be used being determined by the under text, the difficulty of finding words for the upper text which will at once make apparent sense and employ precisely that number of letters becomes very great indeed. In three passages Bacon gives up the attempt to make even apparent sense of the upper text, and concludes with a series of meaningless letters. These three passages are those which close the three sections or "Words" of the *Treatise of the Three Words*. The printed text and that of the manuscripts differ considerably: in the earliest manuscript,[32] the *Third Word* concludes as follows:

"Woe to such persons, for, just as a man who has one eye can lead a blind man hither and thither, so these sophists lead men hither and thither, because they do not look to the truth. And if any sayings are, with you, bound, write back, and I will loosen the bonds with the aid of the one God in Trinity, and of the Trinity in Unity. Farewell. Here ends vcrdhsm mcnezdhsar Rlicrh azdsn ad fratrem hlgznunc de ozrht Alk—."

A second object which Bacon probably had in view in thus permitting himself to use obvious cipher was to supply any unduly suspicious reader with false clews, in following which he would be led off on a wild-goose chase, ending nowhere. For example, the words "to brother hlgznunc about ozrht Alk—" would suggest to

[31] [That is, the upper text is obviously meaningless, not making even apparent sense.]

[32] British Museum, Cott. Jul. D v, about 1300. [The meaningless endings of *The Three Words*, as printed, are the following: (1) *Vale et valeant, qui te valere desiderant. Explicit magnum Mendacium.* (2) *Explicit mzhst mcz dhsni Rlicrhaz dsnze hlgz nucm & ozrht.* (3) *Vale & valeant & de Azthc Alk. Explicit verdhsm menetz dhsm Zlierh Azdsu ad fratrem Helegg.* The manuscript readings may be read in the accompanying Plate.]

Plate IX

Nonsense Words (underlined) at the ends of the chapters of the *Tractatus Trium Verborum*

British Museum Sloane 1754, 63 r, 65 r, 75 r

Courtesy of the British Museum

anyone that *hlgznunc* is a proper name and that *ozrht* is some attribute or subdivision of alchemy; if then one could correctly guess the meaning of these words one might imagine himself in possession of ten letters of a simple substitution alphabet. But in fact *ad fratrem*, *de*, and *Alk*— are themselves part of the cipher upper text; their meanings are of no significance to the reading of the cipher. To read them one must convert the pairs of letters of which they consist, into Bacon's phonetic alphabet, as I have above explained. Thus

fratrem
ineuet
aemsr
n

The well-known gunpowder cipher occurs in the *Letter*, Chapter XI.[33] Prior to the appearance of Brewer's edition, only one form of it was known:

luru vopo vir can utriet

although in the printed editions *u* is sometimes used for *v* and vice versa. But this form is found, Mr. Voynich tells me, in the printed editions only, all of which descend from one printed anonymously at Paris in 1542, which was probably edited by John Dee. The manuscript from which this edition was taken has been lost, and in all known manuscripts another form is found of which Brewer gives one recension in a footnote. He does not specify the manuscript from which he took it except as "the Sloane MS"[34], but the only Sloane manuscript which contains it, Sloane 2156, does not contain the form given by Brewer. In that manuscript the text runs as follows:

κβ κα ψhopospcadiκis . Γuel phosris scilicet

Here Bacon uses a new device—the introduction of letters taken from other alphabets than the Latin. Evidently this is not done for the further concealment of the letter as such, for most of the Greek letters, e.g. α, β, δ resemble their Latin equivalents so closely

[33] [Brewer, *Op. Ined.*, p. 551.]
[34] Brewer, p. ix, note.

that they are intelligible to those that know no Greek. It is in fact only another device for introducing a letter-group. In reading, one must substitute for each letter its name. For example, the above line must be written out thus:

kappabetakappaalphapsihopospcadikappais-

The [next] letter, resembling an E, is not an E, but a combination of three of Bacon's shorthand letters which the fifteenth century scribe has fortunately copied exactly as it looked to him; the quarter-circle is *b* and the two short horizontals are two *t*'s. [According to Bacon's usual practice, the lowermost character is to be read first.] The period which follows this group is also a part of the cipher, and its name *punctum* must be written out in full. The remainder should then be written:

-bttpunctumgammauelphosrisscilicet

The third document containing obvious cipher is the Vatican manuscript. It employs the meaningless letter-groups and letters from other alphabets, including Hebrew and the so-called Tironian signs or Latin shorthand, and also employs another method of expressing nonsense without arousing undue suspicion. The text proper is written in the usual nonsense Latin with just enough semblance of sense to deceive the unwary reader into fancying that he understands it, but at frequent intervals words which have no relation either in meaning or in construction to the context are slipped in under the disguise of word-signs or hieroglyphics. There is no way of learning what words these signs represent except by guessing and then testing the guess by its ability to make sense in the under text. For example, the sign ·⁂· is quite certainly to be read *asteriscus*, and that word must be substituted for the sign wherever it occurs, and treated as part of the upper text. An analogous trick, used in the Vatican document and in the manuscript form of the gunpowder cipher, but not elsewhere, so far as is now known, is the introduction of punctuation and correction signs, which must be treated in the same way. The period must be read *punctum*; the caret-sign must be read *caret* or *carent* [according to whether the omission is of one, or of more words]; the dot under a letter, which was the symbol for striking out or "expunging"

a letter, must be read in the same way: for example, ʒʒ must be read *ʒʒecspunctis*. The only proof that this is the right way to treat these signs is, as I have just said, the fact that when so treated the under text makes sense. But this is by no means conclusive, especially in view of the limited amount of material available for the application of the test. Moreover, it is not unlikely that yet other tricks of concealment will be discovered. But I am quite convinced that all will be found to be merely different ways of applying the same fundamental principles.

CHAPTER V

Following the Clues

In November or December of 1915, Mr. Voynich, in one of his frequent visits to Philadelphia, showed me the cipher manuscript,[1] and told me that although it had been found in Austria, he believed it to be the work of Roger Bacon. I devoted only a few minutes to examining the manuscript. Curious and interesting as it was, it lay quite outside my field of work, and at the moment I was more concerned with other books and manuscripts which lay within my field. Mr. Voynich's opinion, that it was the work of Roger Bacon, seemed to me very improbable; still, on the chance that there might be something in it worth considering, I dropped a note to a friend whom I knew to be working on Bacon and told him of it.

Also, I saw Mr. Voynich frequently during the next three years. I do not recall any reference to the cipher manuscript in our conversation until the end of January 1919, when he told me that he had had photostats made of the manuscript and that several scholars were trying to solve the riddle which it presented. I asked Mr. Voynich to give me a few photostats, simply as curiosities. A few days later he sent me three, of which, by a happy chance, the last page of the manuscript was one.

So far I had had no thought of trying to solve the mystery myself. I knew virtually nothing of ciphers. When I was a child I invented and used in my diaries, as many children do, several simple ciphers, and when [I was] a little older Poe's story *The Gold Bug* inspired me and a cousin of about my own age to compose ciphers, each for the other to solve. But our imaginations devised nothing more complicated than simple alphabetic ciphers, and our principles of convention were merely those expounded by Poe. Of the modern complicated ciphers and of the science of decipherment, I knew noth-

[1] [This Chapter was found in Newbold's handwriting, in a highly abbreviated orthography, in many respects resembling that of mediaeval manuscripts. It appears to be a discarded first draft of what is now Chapter VI. But it has a peculiar interest which justifies its inclusion here, and it does not duplicate materially the following Chapter, to which it forms an introduction.—RGK]

ing. But within a very short time, an hour or two, after receiving the photostats, the idea occurred to me that the mysterious two and a half lines on the last page, written partly in cipher and partly in plain Latin, was nothing less than the Key to the cipher, and with the idea arose a desire to know what it meant.

I do not know what suggested the idea. I think it was the seeming importance of the solitary "Sentence," written so carefully in solitary grandeur on the last, the only blank, page of this manuscript which obviously must have been for its author the crown of a whole life of labor. What could he have thought of sufficient importance to warrant its being given such a position, except the Key without which all the labor of that life might prove to have been expended in vain?

The Key begins

michiton oladabas multos te tccr cerc portas

Disregarding the obviously cipher elements *ton ola te tccr cerc*, and assuming for the moment that *multos* is an error for *multas*, one has an intelligible Latin sentence:

"To me thou gavest (*or* wast giving) many gates."

First I counted the number of letters in this sentence, and found it to be twenty-two. This is the number of letters in the sacred Hebrew alphabet, with which Bacon was familiar; and the Latin alphabet of twenty-three letters can easily be adapted to it by omitting one of the three superfluous letters, *k*, *q*, *y*, of which the first two were pronounced like *c*, and the third like *i*.[2] So I assumed, and it chanced to be right, that *k* should be omitted, and I wrote such an alphabet under the sentence:

m i c h i	*d a b a s*	*m u l t a s*	*p o r t a s*
a b c d e	*f g h i l*	*m n o p q r*	*s t u x y z*

Thus at the very outset, within two or three hours after receiving the photostats, I had one of the basic alphabets of the cipher nearly right. It is indeed, I think, the form first used by Bacon. But in the cipher as finally perfected *x* was omitted, its place being taken by *v*.

[2] [That is, in Bacon's time, though not in the time of Caesar and Cicero.—RGK]

The following day I obtained new and striking confirmation of my hypothesis that the "Sentence" of the last page is really the Key:

The closing words are *so nim gaf mich o*.[3] Now whatever the language of these four words, there is no shadow of doubt as to their meaning. *Gaf mich* means "gave me" and must refer back to *michi dabas*. *So nim* means "so take," and "take" must mean "use" or "understand." Thus the author concludes the sentence with a plain command in contemporary English or its equivalent: "Thus take, use, understand the sentence beginning *michi dabas*." Obviously this *so* must refer to the section written in cipher, beginning *m* [after *portas*] and extending to *ubren* [before *so nim*]; in this section must be contained the way in which one should take, use, understand the sentence *michi dabas multos portas*.

It was now possible to start the problem. The sentence *michi . . . portas* must contain the alphabetic symbols, the section *m . . . ubren* the alphabetic values of these symbols. The first step, therefore, was to determine the nature of the symbols.

I found a clue in the word *portas*, "gates." I had studied the Kabbalah, that curious gnostic philosophy of mediaeval Judaism, and I knew that Bacon had some acquaintance with the ideas best known to us as elements of the Kabbalah. Now, in the Kabbalah, the "gates" are all the possible combinations of the letters of the Hebrew alphabet, taken two by two.[4]

[3] [But see Chapter IX for the final reading of these letters.—RGK]

[4] The term "gates" or "doors" is suggested by the "gates" of the Kabbalah. In that Jewish gnostic philosophy the universe consists of God's thought; thought is expressed in speech; speech is composed of letters; hence the Letters are the ultimate constituents of Things. The "gates" are the 231 biliteral combinations of the 22 Hebrew letters (doubles omitted; 231 permutated pairs added by later writers); they represent the primary combinations of the highest manifestations of the divine Being which are at once the forces which make other things, the material of which they are made, and the channels through which the divine energy streams forth into the lower world. A single quotation must suffice (*Sepher Yezirah*, ed. I. Kalisch, New York, 1877; p. 2, line 5): "He combined (the Letters), weighed them, exchanged them, Aleph with all and all with Aleph, Beth with all and all with Beth, and they go (each) all the way around (the Alphabet). And they are found (comprised) in 231 gates, and everything formed and everything uttered is found to proceed from one Name."

That Bacon knew something of Kabbalah is indicated by his allusions to two forms of the "literal Kabbalah" (S. L. M. Mathers, *The Kabbalah Unveiled*, pp. 6–14); "Gema-

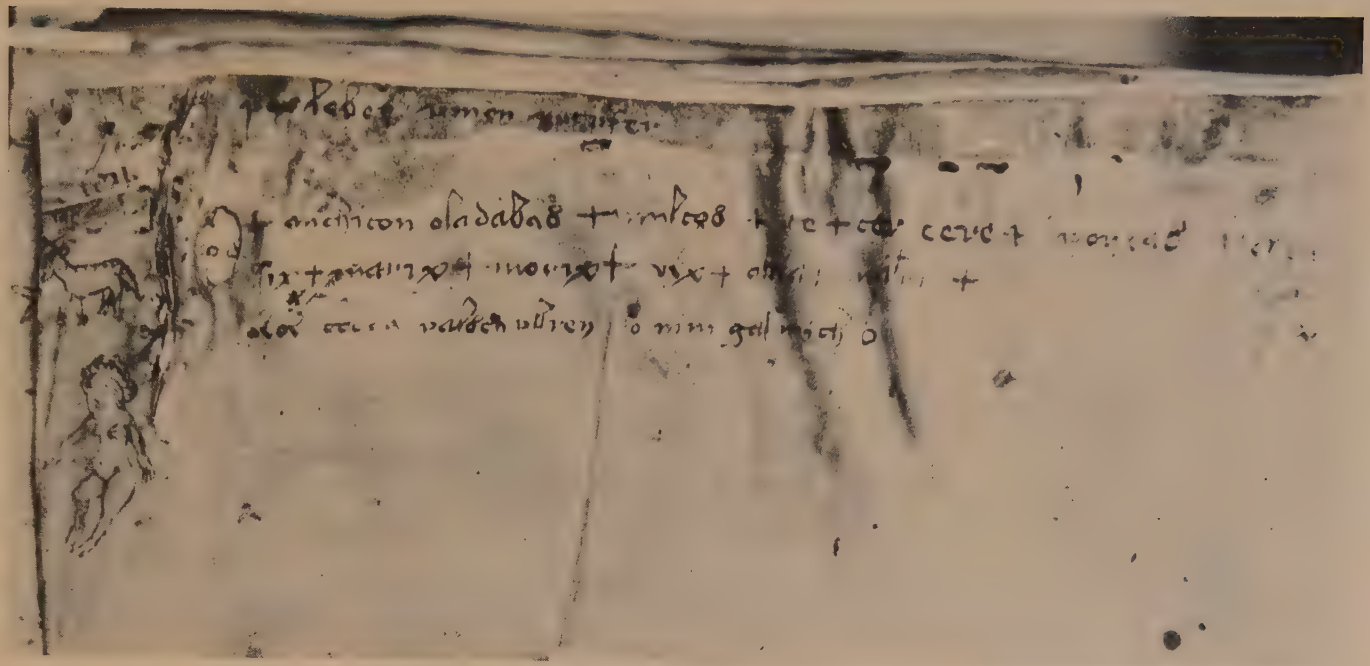


Plate X

The Key on the last page of the Voynich Manuscript

Courtesy of Wilfrid M. Voynich

Since each letter [of the twenty-two in the Hebrew alphabet] must be combined with twenty-one others, the total number of "gates" or pairs will be 21 x 22, or 462. If doubled letters are admitted, one must add 22 other pairs, making the total number of gates 484. If this be the meaning of "gates" in the Key Sentence the adjective "many" becomes eminently appropriate, a fact which I took as *pro tanto* confirming the hypothesis.

The four concluding words, *so nim gaf mich*, indicate that the "gates" or biliteral alphabet should be derived from the Key Sentence, but the method of derivation remained to be found, and it proved a difficult task. It was not until July, five months after beginning the work, that the solution occurred to me: Divide off the Key sentence, including the inserted cipher elements, into pairs of letters, and derive from them the possible pairs not found in it, by means of the uniliteral alphabet.[5]

I found some confirmation of this theory in the study of these syllables of the second part of the Key, which were written in Roman letters. They were, or seemed to me to be,[6]

fix (or *lix*) *quarix morix ahca* (or *ahta*) *maria ualscn ubren*

I assumed that such combinations as *ton* and *ola* must be read *to on*, *ol la*, to adapt them to a biliteral system, and this suggested that longer words should be treated likewise. I found that several of these syllables [or rather biliteral groups] could be derived by the uniliteral alphabet, or from a syllable occurring in the Key sentence, or from such syllable written backward. Thus *hc* occurs in *michi*, *al* in *ola*, *or* in *portas*; *ub* [does not occur in the Key sentence, but when] reversed[7] [by the uniliteral alphabet] becomes *ri*, and *ri* [similarly treated, becomes] *sa*; *sa* does not occur in the Key sentence, but *as* does. [Similarly,] *ls* converts into *op*, which is the *po* of *portas*

---

tria" as applied to the 95th Psalm (Vulg. 96th Hebr.) (*Oxford Greek Gram.* p. 195, lines 1–5); and "Temurah" in two of its forms, the alphabet "Athbash" (*Hebr. Gram.* p. 206 et al.), and Bacon's sixth kind of cipher (*Op. Ined.* p. 545), which is the "Kabbalah of the Nine Chambers." So also in Bacon's cipher the "gates" are the channels through which alphabetic values are conveyed from the Key Sentence to the 484 biliteral symbols.

[5] [This process is explained in the next Chapter.]

[6] [Some of these values were altered after further study; see Chapter IX.—RGK]

[7] [To "reverse" and to "convert" are to change by the reversion alphabet and by the conversion alphabet, respectively; see Chapter VI and Chapter XX, Table I.]

written backward; *mo* [converts] into *at* [found twice, though backwards,] in *multas portas*; *ca* [converts] into the *ci* of *michi*; *fi* and *ar* revert to the *da* and *ms* of *dabas multas*.

But others of these syllables could not be thus reduced, for example *qu*, *ua*, *ah*, *sc*, *sn*, *br*, *re*, *en*. It was chiefly from the study of these syllables that I discovered the system of substitutions in both the uniliteral and the biliteral alphabets. The most important of these substitutions is that of *quatuor* for *te tccr cerc*. I had already guessed that *ton ola*, following *michi*, contained an indication of the author's name, and that the three cipher words following *multas* contained the number of "gates" or alphabets. Now the first of these [three] is clearly *te*; the second may be read either *tccr* or *tar*. If read *tar*, one has the first two syllables *te-tar-* of the Greek word τέτταρα "four." This fact, combined with the need of having *qu* and *ua* in the Key sentence, led me to experiment with *quatuor* as a substitute for *te tar cerc*, which has proved to be correct. But it was long before I discovered Bacon's reason for writing *te tccr cerc* instead of *quatuor* in the Key sentence.

So far I have tacitly assumed that *multos* should be read *multas*. And, obviously, the assumption is absolutely justified by the laws of syntax. If the reading *portas* is correct, the seeming *o* in *multos* cannot be an *o*, it must be an *a*. But it is then necessary to explain by what principles an *o* may be read as an *a*.

At first glance the *o* seems carelessly formed. But upon closer examination, even with the naked eye, one sees that it is not carelessly made, it is made of distinct elements conjoined with great care. The first element to the left resembles the letter *c*. The second, attached to the top of the *c*, is an inverted *e*, somewhat tilted. The third resembles the caret mark, ∧. Thus the *o* is really . I took this as a monogram: the first letter is *c*, the second an inverted *e*, to be read as *e*. But the third I could not read, and it was only after weeks of experimentation that I finally determined its value to be *q*. At first I could not explain why ∧ signifies *q*, nor how *ceq* may be taken as a monogram for *a*, but when the rules and values for symbols were settled, both mysteries were solved. The symbol ∧ is composed of the [two] shorthand letters, \ = *n* and / = *e*, [making] *ne*, [since one is reading around the circle from left to right above and then from right to left underneath. This *ne*,] by an invariable rule [which I have termed "commutation" and shall

explain later,] must be read *ni*, which is *q*.[8] So also the monogram *ceq*=*ce eq* = *tb* = *oi* = *a*.

But what was the author's motive for writing the *a* in so curious a form? I guessed, and fortunately guessed right, that he did it in order at once to expand his alphabets. The original uniliteral alphabet contained only fourteen [different] letters, *m i c h d a b s u l t p o r*. Several letters necessary for the writing of Latin were lacking, notably *e* and *n*. Furthermore, one of its letters, *a*, had no less than four values in the converse alphabet, *g*, *i*, *q*, *x*, and in the reverse alphabet all these four letters would of course be represented by *a*. *S* had three values, *l*, *r*, *z*; *m* [had] two [values], *a* and *m*. By substituting *tceqs* for *tas*, one *a* is eliminated, and two new letters introduced into the uniliteral alphabet, *e* and *q*. It remained to determine the equivalents which should be assigned to these new letters.[9]

[8] [When converted, *ni* gets the alphabetic value *q*.]

[9] [The manuscript here stops abruptly; but the method and the line of argument are obvious. The next Chapter makes the complete explanation.—RGK]

CHAPTER VI

The Derivation of the Biliteral Alphabets

The most original and ingenious feature of Roger Bacon's Latin cipher[1] is that which I have explained in Chapter IV, the idea of employing the pairs of letters occurring in a seemingly continuous Latin text as an alphabet for the expression of a second or under text. But the method by which he attached the alphabetic values to these pairs of letters seems to me scarcely less original and ingenious. Comprehension of it is essential to the complete understanding of the cipher as a whole, but it is not necessary for the mere reading of the cipher. For that, the Table of Alphabets[2] suffices. The object of this chapter is to explain the principles and laws by means of which that Table was constructed.

Bacon could, no doubt, have formed a rough estimate of the frequency of occurrence in an average Latin text, of the letters of his phonetic alphabet, on the one hand, and of the biliteral symbols on the other, and could then have assigned the former to the latter in such manner that the more frequently occurring letters would be conjoined with the most frequently occurring symbols. It is not impossible that his distribution was based in part at least on this principle. But this method would not have been congenial to the scholastic mind, trained from childhood in the method of Aristotelian science. According to the Aristotelian ideal, a science is a body of knowledge deduced by syllogistic reasoning from comparatively few and absolutely certain principles. In the basic sciences these principles are themselves derived from no others; their certainty is, so to speak, confined within themselves, and is self-evident to the eye of the intellect. But the principles of the inferior sciences may be taken from the conclusions of the higher sciences. A method of derivation based upon nothing but the comparative frequency of letters, which he probably would have regarded

[1] [This Chapter was left by Newbold in finished form. The Editor has added the Appendix.—RGK]

[2] [See Table VI of Chapter XX.]

as due to nothing but chance and certainly could not have derived from a higher principle, would have seemed to a scholastic philosopher unworthy of a scientific intellect. The law of the cipher must be framed in accordance with sound scientific principles.

Bacon therefore lays down as the basis of the entire system the Key Sentence, [found on the last page of the Voynich manuscript]:

Michi dabas multas portas
"To me thou gavest many gates"

The motives which guided him to the choice of this sentence will never be known unless his own explanation of them be discovered. I shall however later discuss certain considerations which I think were among those that influenced him (see Chapter ■).[3]

From this sentence are derived independently:

The Two Primary Uniliteral Alphabets.
The Four Primary Biliteral Alphabets.

From the two primary uniliteral alphabets are derived:

The Two Secondary Uniliteral Alphabets.

From the four primary biliteral alphabets are derived:

The Four Secondary Biliteral Alphabets.

The Primary and Secondary Alphabets, both uniliteral and biliteral, are in the main the same; they differ in that in the secondary alphabets certain symbols of the primary are omitted, their places being taken by new symbols, more in number than those omitted. The aim of this modification is the introduction of more symbols in order to increase the flexibility of the cipher; hence the omitted primary symbols are not discarded altogether: they retain their validity and some of them are in frequent use, but the majority occur only rarely. One may therefore combine the primary and the secondary alphabets into:

The Two Complete Uniliteral Alphabets.
The Four Complete Biliteral Alphabets.

[3] [This Chapter also is among those never written, and therefore entirely lost.—RGK]

In theory one must regard these complete alphabets as the final and most authoritative form of the uniliteral and biliteral alphabets, but in practice it will be found that the secondary values are in the more constant use.

In the last place, from the four complete biliteral alphabets are derived:

The Eight Auxiliary Biliteral Alphabets.

These twelve biliteral alphabets, the four complete and the eight auxiliary, are those actually used in writing in Bacon's cipher. The symbols which they comprise I term the "basic symbols," because the alphabetic values of all the symbols not found among them is determined by reference to them. If one should wish to read the cipher without constant reference to the Table of Alphabetic Values, it is necessary to memorize these twelve alphabets together with their values.

I. The Primary Uniliteral Alphabets

The Key Sentence contains twenty-two letters. The primary uniliteral alphabets are derived from it by the simple expedient of writing under it a Latin alphabet of twenty-two letters, *k* and *x* being omitted and *v* being introduced in addition to *u*, thus:

```
M I C H I D A B A S M U L T A S P O R T A S
a b c d e f g h i l m n o p q r s t u v y z
```

There are two possible ways of employing this set of equivalents in the translation of a text into cipher: One may take the letters of the Key Sentence as representing the letters of the text and substitute for each its equivalent in the alphabet, thus:

IUSTITIA = bnlpbpbg

Or one may take the letters of the alphabet as representing the letters of the text and substitute for each its equivalent as given in the Sentence, thus:

iustitia = ARPOAOAM

From these two ways of using the equivalents are derived the two primary uniliteral alphabets. That derived from the first method I term the "Conversion Alphabet," that derived from the second

[I term] the "Reversion Alphabet." When we rearrange the letters of each in alphabetic order for convenience in use, the two alphabets are these:

The Primary Conversion Alphabet

A = g, i, q, y	M = a, m
B = h	O = t
C = c	P = s
D = f	R = u
H = d	S = l, r, z
I = b, e	T = p, v
L = o	U = n

The Primary Reversion Alphabet

a = M	h = B	r = S
b = I	i = A	s = P
c = C	l = S	t = O
d = H	m = M	u = R
e = I	n = U	v = T
f = D	o = L	y = A
g = A	p = T	z = S
	q = A	

II. The Secondary Uniliteral Alphabets

Even superficial consideration will show that these alphabets, and the conversion alphabet especially, are not well adapted to the end which they are supposed to serve. The conversion alphabet contains only fourteen of the twenty-two letters, the eight missing being E F G N Q V Y Z. In using this alphabet, it would be necessary to regard these letters as represented in the alphabet by their nearest equivalents, I P C M C U I S. Again, A has no less than four equivalents, *g i q y*; S has three, *l r z*; M has two, *m* and *a*; I has two, *e* and *b*; T has two, *p* and *v*. This introduces considerable ambiguity into the conversion of a reverted text.

In order to remove these difficulties by increasing the number of letters in the Key Sentence, Bacon substitutes for three of the A's and for one of the M's cipher equivalents taken either direct from the primary biliteral alphabets or introduced into the secondary with the values here given them. For the second A of DABAS he substitutes *PQ*, which has the value of A; for the M of MULTAS, he substitutes *NV*, which signifies M in the secondary alphabet. For the A in MULTAS, he substitutes a monogram *CEQ*, which, in accordance with the general rule, must be read *CE EQ*. These are respectively symbols for T and B, and *TB* signifies A. So also for the A of PORTAS he uses the monogram *QPI* = *QP PI* = *MI* = *A*. Thus four of the eight missing letters, E N Q V, are introduced into the Key Sentence.[4]

[4] [All the values here given are "alphabetic" and not "phonetic;" see p. 85. These values are given in minuscules in Tables III and IV of Chapter XX; except that TB is not a base, but gets its value by reversion to OI, found in the last line of Table IV.—RGK]

In the corresponding alphabet, suitable equivalents are provided. The two *P*'s receive their usual value, *s*. The monogram CEQ is given *k q c*, of which *k* and *c* are phonetically identical with the *q* which occupied this place in the alphabet. Thus the C of the sentence, of which the equivalent was *c*, acquires the new equivalent *k*, while the two new letters of the Sentence, *E* and *Q*, receive *q* and *c* respectively. The new *N* of the Sentence corresponds in position to *m* in the alphabet; the *V*, being identical phonetically with U, has the same equivalent, *n*. So also the I of *QPI* corresponds to *y*, and the accepted values of the *QP* introduce *cs* = *x* into the alphabet in the position of *x*.

With these substitutions, the secondary system of values assumes the following form:

M I C H I D A B *P Q* S *N V* U L T *C E Q* S P O R T *Q P I* S
a b c d e f g h *s c* l *m n* n o p *k q c* r s t u v *c s y* z

The secondary uniliteral alphabets will then be as follows; [the distinctly secondary values are indicated by italics:]

The Secondary Conversion Alphabet

A = g	*N* = *m*
B = h	O = t
C = c, *k*	P = s
D = f	*Q* = *c*
E = *q*	R = u
H = d	S = l, r, z
I = b, e, *y*	T = p, v
L = o	U = n
M = a	*V* = *n*

The Secondary Reversion Alphabet

a = M	l = S	u = R
b = I	*m* = *N*	n = T
c = C, *Q*	n = U, *V*	*y* = *I*
d = H	o = L	z = S
e = I	p = T	
f = D	*q* = *E*	
g = A	r = S	
h = B	s = P	
k = *C*	t = O	

III. The Complete Uniliteral Alphabets

The complete uniliteral alphabets are constructed by combining the primary and the secondary uniliteral alphabets:

The Complete Conversion Alphabet

A = g, i, q, y	*N* = *m*
B = h	O = t
C = c, *k*	P = s
D = f	*Q* = *c*
E = *q*	R = u
H = d	S = l, r, z
I = b, e, *y*	T = p, v
L = o	U = n
M = a, m	*V* = *n*

The Complete Reversion Alphabet

a = M	n = U, *V*
b = I	o = L
c = C, *Q*	p = T
d = H	q = A, *E*
e = I	r = S
f = D	s = P
g = A	t = O
h = B	u = R
i = A	v = T
k = *C*	y = A, *I*
l = S	z = S
m = M, *N*	

These alphabets are used in the building up of the system of biliteral symbols. The ways in which they are used will be explained as occasion arises.

IV. The Four Primary Biliteral Alphabets or "Gates"

The four primary biliteral alphabets, or "gates," are derived, like the uniliteral alphabets, from the Key Sentence, and by an analogous procedure. The uniliteral alphabets are derived by assigning to the letters of the Key Sentence, taken one by one, alphabetic equivalents; the biliteral alphabets are derived by assigning analogous equivalents to them *taken two by two*. But since the Sentence contains only twenty-two letters and so would yield only eleven symbols, Bacon expanded it from twenty-two to thirty-five letters by inserting *TON OLA* after MICHI and *QUATUOR* after MULTAS. These insertions are not arbitrary. *Quatuor*[5] is explanatory of *multas*, telling how many "gates" have been given to

[5] [The spelling *quatuor*, with one *t*, is a familiar late Latin spelling; but the word itself is not actually to be found in the Key: it is there enciphered in a Greek translation. Reference to the Key and to its interpretation (Chapter IX) will show that Newbold read the letters between *multas* and *portas* as + *te tccr cerc*, which has been interpreted elsewhere as A C O N I (Chapter I, note 28), to be attached to the R B represented by the *ton ola* standing between *michi* and *dabas*. But for the value as a numeral Newbold kept the *te* as it stands; read the *cc* as *a*, either because the two letters are so cramped together as to resemble that letter, or because *a* is an alphabetic value of *cc*, so that we have *tar;* and then, taking *ce rc* as equal to (alphabetic) *t i*, and *ti* as (alphabetic) *a*, he got a total of *tetara*. This he read as Greek, with a single *t*, for the double: τέ(τ)παρα, and translated it by *quatuor*, its Latin equivalent, which he used in the construction of the Alphabets.—RGK]

Bacon, and *ton ola* is a cipher monogram for Bacon's own initials, *to on* = *sl* = R and *ol la* = *iq* = B.[6] Thus these interpolations make the meaning of the fundamental Sentence more explicit, but do not essentially alter it, a point upon which Bacon probably would have insisted as of great importance. It now reads:

MICHI TON OLA DABAS MULTAS QUATUOR PORTAS
"To me, R(oger) B(acon), thou gavest many—four—gates"

Since the expanded sentence contains an odd number of letters, it will not divide into pairs without remainder, and to make it do so Bacon must either add or subtract one or more letters. He decides to omit the *h* in MICHI. I think the reason for his decision was to make the biliteral symbols coincide more nearly with the natural division of the syllables. But it is a somewhat surprising decision, nevertheless. In Bacon's published works,[7] he remarks upon the incorrectness of the spellings *michi*, *nichil*, which were customary in his time, saying that all ancient manuscripts have *mihi*, *nihil*.[8] One would expect him therefore to omit the *c* rather than the *h*. Yet the phonetic values which are attached in the cipher Latin to the symbol occupying this position, and to its derivatives, show that it must have been *ci* and not *hi*. Moreover, in his own phonetic alphabet he always spells these words *mici* and *nicil*.

Omission of the *h* reduces the number of letters to thirty-four, which yields seventeen pairs. To these is added the word *et* 'and,' which serves the double purpose of linking the First Alphabet to to the Second and of introducing into the First Alphabet an eighteenth symbol. The First Alphabet then comprises the following symbols:

MI CI TO NO LA DA BA SM UL TA SQ UA TU OR PO RT AS ET

In forming the Second Alphabet, Bacon retained the spelling *michi*. The second *i* then becomes the fifth instead of the fourth letter, and in the division into pairs it must be paired with the following instead of the preceding letter. So also of the subsequent

[6] ["Alphabetic" values; see Chapter I, note 28.]
[7] *Oxford Greek Grammar*, pp. 131–132; *Opus Tertium*, p. 245.
[8] [See Chapter IV, note 7.—RGK]

letters: each will change its partner, thus giving a series of symbols differing from that of the First Alphabet, with the exception of two, *as* and *ta*, which reappear in the Second Alphabet in different positions. The thirty-five letters divide into seventeen symbols with one letter, *s*, as a remainder. The eighteenth symbol is obtained by substituting for this *s* one of its cipher equivalents, *ti*.[9] The Second Alphabet then is:

MI CH IT ON OL AD AB AS MU LT AS QU AT UO RP OR TA TI

The Third and the Fourth Alphabets are derived from the First and the Second respectively, simply by reading the symbols backward, from right to left. They are:

(3) IM IC OT ON AL AD AB MS LU AT QS AU UT RO OP TR SA TE
(4) IM HC TI NO LO DA BA SA UM TL SA UQ TA OU PR RO AT IT

V. The Four Secondary Biliteral Alphabets

The four "gates" are derived directly from the Key Sentence by interpolating in it the new elements *ton ola* and *quatuor* and dividing off the expanded sentence into pairs, as I have just explained. The secondary alphabets are derived in precisely the same way, except that this procedure is applied to the Key Sentence *after* the substitutions for the three *a*'s and one *m* have been made in it. [These alphabets consist not of eighteen symbols, but of twenty-one.] Thev contain eleven additional biliteral symbols, *bp pq nv sn vu tc eq ce zs tq pi;* and these, when read backward, yield eleven more, *bp qp vn ns uv ct qe ec si qt ip*. The alphabets are as follows, the interpolated letters being distinguished by italics:

(1) MI CI TO NO LA DA B*P* *Q*S *NV* UL T*C* *EQ* SQ UA TU OR PO RT *QP* *I*S ET
(2) MI CH IT ON OL AD AB *PQ* S*N* *V*U LT *CE* *Q*S QU AT UO RP OR T*Q* *PI* TI
(3) IM IC OT ON AL AD *P*B S*Q* *VN* LU *C*T *QE* QS AU UT RO OP TR *PQ* S*I* TE
(4) IM HC TI NO LO DA BA *QP* *N*S *UV* TL *EC* S*Q* UQ TA OU PR RO *Q*T *IP* IT

VI. The Alphabetic Values

To these eight alphabets, four series of alphabetic values are provided. Each is based upon the ordinary alphabet, and some of its terms still follow the alphabetic order, but there are so many

[9] ["Alphabetic" value in the fourth primary alphabet; see Chapter XX, Table II.]

omissions, substitutions, and additions, that they seem to be quite arbitrary, betraying no trace of any guiding principle.[10]

The values attached to the Second and the Third Primary Alphabets retain in part the usual order of the letters:

(Primary, II and III) a b c t i i p c l m n p q r s t u a

Those belonging to the First and the Fourth have in part the same order, but are read backwards:

(Primary, I and IV) u t s r q p n m l c q q i t c b a b

The values given to the Secondary Alphabets are derived from these, but not in accordance with any discernible principle:

(Secondary, II and III) a b c t i i p i c l m n o p q r s t i o a
(Secondary, I and IV) u t s r q p n o m l c b q q i t c b o b b

But these values are themselves *never* used in either the Latin or the shorthand form of Bacon's cipher texts. Their very existence would be unknown, were it not that they are used in the Key written on the last page of the Voynich manuscript. Elsewhere, without exception they are treated as mere *signs* from which the actual letters of the text are obtained by substituting for them their equivalents as given in the uniliteral reversion alphabet.[11] These equivalents, again, must be taken as letters of Bacon's phonetic alphabet,[12] and for that reason I term them the "phonetic" as distinguished from the "alphabetic" values. In Table II of the Chapter of Tables, I have given the alphabetic values only, in minuscules. In Table III [and Table IV, the alphabetic values are still given in minuscules, but] the phonetic values, printed in capitals, are attached also, each to its corresponding alphabetic value. In the remaining Tables, the alphabetic values are omitted, the phonetic values alone being given, for it is with them alone that the reader[13] is concerned.

It was indeed from these phonetic values that the omissions, substitutions, and additions in the alphabetic series were ascertained. When I first constructed the biliteral alphabets I gave them values corresponding, as far as possible, with those of the ordinary Latin alphabet. Then I tried to read the Latin cipher texts, but found

[10] [See however Chapter IX, page 110.—RGK]

[11] Found on pages 82–83, [and in Chapter XX, Table I.]

[12] See page 55.

[13] [That is, in the interpreting of cipher texts.]

that they made no sense. Then I tried the experiment of translating these values into those of the conversion and the reversion alphabets. Again, the conversion alphabet made no sense, but the reversion alphabet gave me at once either complete Latin words or fragments of words which could readily be completed from the adjacent letters. Further experiment showed that some of my values must be wrong, so I substituted for them others which made better sense. After many months of work I assembled these values and constructed out of them the tables of alphabets. But in many cases the phonetic values which I had determined thus directly by experiment might be derived from more than one alphabetic value. Either *b* or *e* would give a phonetic I, *t* or *n* would give phonetic U, *l* or *r* or *z* would give phonetic S, *o* or *u* would give phonetic R.[14] Hence the alphabetic values, although I have represented them as the originals, are in reality less well known than the phonetic, for they are the true originals from which the alphabetic were inferred.

VII. The Four Complete Biliteral Alphabets

The four complete biliteral alphabets are constructed by combining the primary alphabets and the secondary alphabets in such a way that all the symbols and values found in each are retained. They will be found in Table III of Chapter XX.

VIII. The Eight Auxiliary Biliteral Alphabets

From each symbol of the complete biliteral alphabets two new symbols[15] are formed, one by the process of conversion and the other by that of reversion. The symbol *or*, for example, when translated by the conversion alphabet, becomes *tu*, and when translated by the reversion alphabet, *ls*. These two symbols, *tu* and *ls*, are then treated as identical with *or* and receive the same alphabetic and phonetic values. By applying this procedure to all the symbols of the four complete alphabets, one obtains the eight additional alphabets which I term the "auxiliary" alphabets.[16]

[14] [Since phonetic U includes *o u v*, and phonetic R includes *l* and *r*.]

[15] [Or two *sets* of symbols, if the letter to be converted or reverted has more than one value in the conversion or reversion alphabet.]

[16] [These are to be found in Table IV of Chapter XX.]

IX. The Basic Alphabets

It is to these twelve complete alphabets, that the alphabetic and the phonetic equivalents are directly attached; and for that reason I term them the "basic" alphabets. [The symbols found in them, I term "bases," and the values of the bases I call "basic" values.]

X. Reduction of Symbols to their Bases

I remarked at the beginning of this Chapter that the method devised by Bacon for attaching alphabetic values to his 529 biliteral symbols was by no means the least ingenious feature of his extraordinarily ingenious system of ciphers. And I have shown in the preceding paragraphs how he derives a very large number of them from a few elementary assumptions by means of a comparatively simple system of rules. It remains to show how the symbols not as yet accounted for are brought within the system.

This is done by the simple process of "reversion." Any symbol not found among the bases must be translated by the reversion alphabet into a basic symbol, and then receives the value [or values] of that symbol. The symbol *bu*, for example, reverses to *ir*, which is a basic symbol with the phonetic values C M U; these are then the values of *bu*. If a single reversion does not reduce the symbol to a basic form, the process must be repeated until it does. For example, *sd* reverses to *ph*, which is also not basic; *ph* reverses to *th*, also not basic, but *th* reverses to *oi* which is basic and has the values E M. The three symbols *sd*, *ph*, *th* all have then the values E M of their common base *oi*.

In the application of this rule, however, certain problems present themselves, the solutions of which have cost much time and labor, and are, indeed, not all certainly correct.

It will be found by experiment that all the non-basic symbols except nine can be reduced to bases by repeated reversion. The eight, *zz vv uu tt ss rr pp ll*, all reduce to [the ninth,] *oo*, but *oo* reduces to *ll*, and thus the cycle is repeated without reaching a base. This difficulty is evaded by treating *oo* on the phonetic principle as either *ou* = U or *uo* = S; it therefore receives both values, U and S. [The other eight symbols likewise receive the values U and S.]

A similar problem is presented by all non-basic symbols containing

an *n*. An *n* reverses both to *u* and to *v*, but *u* and *v* follow different lines of reversion, *u* reversing to *r* and *v* to *t*. Often one of these lines of reversion reaches a base before the other; which then is to be taken as the base of the symbol in question? The common syllable *en*, for example, reverses to *iv* and *iu*, of which *iv* is a base with the values E M N, but *iu* is not a base; *iu* reverses however at the next step to the base *ar* = C. What is the value of *en*? In this and in all similar cases Bacon follows in theory his general principle, to attach to any symbol as many values as the rules allow; so the values of *en* are E M N C. But in practice it will be found that he habitually uses these polyvalent symbols in only one or two of their possible values, having recourse to the others only where their use occasions no ambiguity. The symbols *en* and *iv* are usually E.

Problems arising out of the relations of the primary and the secondary systems are solved in like manner. For example, the base derived from *mi* by reversion is, according to the primary uniliteral alphabet, *ma*; but according to the secondary, it is *na*. Of these, *ma* is in very frequent use with the values M R; *na* also quite often has these values, but elsewhere in the Table of Bases,[17] it has the value S, and in practice it is much more often used for S than for M R. On the other hand, the basic symbol *me*, which is derived by conversion from *mi* by the use of the primary uniliteral alphabet, I have never found used with the values of *mi*: it is always regarded as derived by the secondary alphabet from *ni* = E.

XI. The Choice of the Phonetic Values

I have already remarked that the alphabetic values attached to the primary and the secondary biliteral alphabets cannot be derived from any superior principles in the way in which a scholastic philosopher would feel that they ought to be derived. I am not satisfied with this assertion as a final conclusion, and although I have not been able to discover any such principle I am by no means convinced that none is to be found. Yet I think it probable that, if Bacon had and used such a principle in his original construction of the alphabets, he would have been forced by necessity, and also in all probability [would have been] inclined by more fanciful considerations,

[17] [The values of bases are found in Table VI of Chapter XX, marked by superior figures 1 to 5.—RGK]

to modify its application in many ways. For example, a very large number of Latin words have a *u* as the next-to-last letter, and Bacon accordingly has provided that all symbols containing a *u* should have many values, in order to avoid the necessity of bringing into his under text any given fixed values of such symbols at points where they would be superfluous and therefore confusing to the reader. Again, I do not think it a mere matter of chance that the symbols composing the word *verbum* 'The Word,' which has been regarded by Christian theologians, ever since the publication of St. John's Gospel, as one of the most significant of the titles of Christ, are given values which spell out clearly *filiu(s)* 'The Son:'

```
v e r b u m
  F I L I U
  m   u s
  n   c
      m
```

While endeavoring to discover such a principle, [that is, a principle for the choice of the phonetic values of the symbols,] I ran across a fact which is sufficiently curious to be worthy of mention, although I am not yet quite convinced as to its significance.

After trying in vain to discover the supposed principle in the alphabetic values of the complete alphabets, I wrote out their phonetic values, beginning at the top of the right-hand column of Table III [of Chapter XX] and continuing to the foot of the column and up the left-hand column, thus:

ropsetuulnnssccieeeaocimliimlaropsetluunnssccattaaocim

While examining it, I observed letter-groups which suggested to me Latin words. The first that I noticed was the group IImLAR, which suggested (H)ILARI(S). The second group was NSSCcAT, (suggesting) SANCT(U)S. Then I saw between these two the group *opset* = UFSET = FESTU(M), and just before *hilaris* was EaOCiML = COEL(U)M or COELI. Now these four words signify related ideas, "heaven," "cheerful," "feast," "saint," which might properly enter into the composition of a sentence. The letters at the head of the line suggested nothing to me, but I guessed that the person most interested in a "cheerful feast of the saints in heaven" (or something of the kind) would be Bacon him-

self. So I arbitrarily took out of those letters the letters of Bacon's name; first the Christian name:

```
R O p S E t u U R n n s s G     R O G E R U S
                l       c
```

Carrying down the remaining letters one finds that they do suggest *Bacon*, although the *a* is lacking:

```
B t O N n s s C         B (A) C O N
p
```

If this is correct so far, one ought to find in the letter-group between Bacon's name and "heaven" an obvious suggestion of a word which will supply an appropriate connection between those two ideas and will also fit into the grammatical construction of the sentence. And one does find such a word:

```
D N S s I E e e A   A D I E N S   "approaching"
```

"Heaven," then, must be in the accusative case and the lacking *u* must be supplied later:

```
s e E O C i M L   C O E L (U) M   "heaven"
```

The next two groups are clear:

```
S e I i I m L A R   (H) I L A R I S   "cheerful"
e i M U F S E T     F E S T U M       "a feast"
    o p
```

Since "saint" or "saints" comes next, one can guess that it will be either *sanctorum* "a feast of the saints," or *cum sanctis* "a feast with the saints." The letter-group fits the latter better than the former, although the *m* is missing:

```
e I l u U N n S S C C A T   C U (M)   S A N C T I S   "with the saints"
```

There remain only eleven letters, and three of them must be used to supply the *a*, *u*, and *m* omitted in the text:

```
e l U n t A a o c i M
```

If the text has been reconstructed aright one must be able to make of the eight letters which are left (1) a principal verb which (2) will use all those letters and need no more, and which (3) will supply

an appropriate completion of the sentence as a whole. I can find just one word that satisfies these conditions:

E R N T A O C I C O E N A R I T "may he feast"
1

After finishing this reconstruction, which took perhaps ten or fifteen minutes, and while copying it out, I was astonished to perceive that I had produced a four-lined stanza of verse:

Rogerus Bacon
Adiens coelum
Hilaris festum
Cum sanctis coenarit.

Changing from the third person to the first for the sake of the meter [in the English], one might translate it:

I, Roger Bacon,
Drawing nigh heaven,
Gladly would feast with
The saints at their banquet.

Where did this little stanza come from? Did Roger Bacon write it and conceal it thus in his compound alphabet? Or did I extract it myself from the depths of my own subconsciousness by means of the chance suggestions supplied by the letter groups? While I do not feel absolutely certain, I am inclined to believe that it is Bacon's work, not mine. In view of the flexibility and consequent ambiguity of Bacon's system it is sometimes possible for the reader to put into an accidental juxtaposition of letters a meaning which they were not intended to convey, and even letter-groups will sometimes lend themselves to the expression of such meanings. Even the fact that the last eight letters just sufficed for the production of an appropriate verb proves nothing, for it must be remembered that these eight letters lack but three of containing the whole of the phonetic alphabet, in which any word may be written,[18] and

[18] [Newbold here is unfair to his own performance. Not every word can be written in the eleven letters of the phonetic alphabet, since many words use one or more of those eleven letters two or even three times. Thus *Rogerus* requires two *r*'s and two *u*'s (= *o* and *u*); *coelum* similarly requires two *u*'s, *hilaris* requires two *i*'s, *sanctis* requires two *s*'s. Further, the lack of a *t* in the eight remaining letters would have made it impossible to construct a verb grammatically suitable to the singular subject.—RGK]

the grouping of the letters does not in any way suggest the verb which I made out of them. But while I was trying to make sense out of, or rather put sense into, the letters, I was not trying to make verse; the verse-form would be purely accidental, and that seems to me distinctly unlikely. Furthermore, one can imagine a plausible reason why Bacon might have selected the phonetic values of his complete alphabets with a view to constructing out of them a stanza of verse. He probably originally gave his biliteral alphabets alphabetic values corresponding to those of the ordinary Latin alphabets, but had been forced by various practical considerations to make so many modifications that little trace was left of the original alphabetic order. This stanza, being easily memorized, would enable Bacon or any other person whom he might entrust with the secret, to carry in memory the entire system of values which should be attached to the complete system of biliteral symbols.[19] Moreover, it would certainly have given Bacon no little pleasure to think that his highest hopes had been thus incorporated, as it were, and given material form in his cipher in such manner that they might be regarded as interwoven with and distributed through everything that he wrote in it. In a later chapter I shall explain more at length the curious system of philosophy which would justify such a conception.[20]

[Appendix]

[The Relative Frequency of the Letters in Latin]

[At the beginning of the chapter I said that] Bacon could, no doubt, have formed a rough estimate of the frequency of occurrence in an average Latin text, of the letters of his phonetic alphabet and of the biliteral symbols, and could then have assigned [values on this basis. He preferred to operate otherwise; but it is worth while to have a record here of the relation of the ordinary Latin alphabet with Bacon's eleven-letter alphabet. The occurrences accordingly of the different letters, I and U including both vowel and consonant values, is as follows; the figures cover the first one thousand

---

[19] [The Editor frankly does not see how this verse, with values rearranged in order and specialized from *l* to *r*, from *c* to *g*, etc., could serve as such a mnemonic key. But that may be the Editor's density.—RGK]

[20] [This promised chapter also was unfortunately never written.—RGK]

letters in Caesar's *Gallic War*, Cicero's *First Oration against Catiline*, and Vergil's *Aeneid*, as well as the average of the three:

Letter	Caesar	Cicero	Vergil	Average
I (= i, j)	106	129	106	113.7
E	115	103	122	113.3
U (= u, v)	87	96	103	95.3
A	95	80	103	92.7
T	82	79	73	78.0
N	89	71	53	71.0
S	60	72	69	67.0
R	58	64	72	64.7
M	57	60	59	58.7
O	50	59	56	55.0
L	43	30	39	37.3
C	21	44	24	29.7
P	24	25	20	23.0
D	16	23	24	21.0
Q	22	14	23	19.7
B	21	14	17	17.3
G	24	6	15	15.0
F	17	14	9	13.3
H	10	14	7	10.3
X	2	3	2	2.3
Y	1	0	3	1.3
K	0	0	1	0.3
Z	0	0	0	0.0
	---	---	---	---
	1000	1000	1000	999.9

The infrequency of K, Y, and Z is due to special reasons. K was only a rare graphic variant of C. Y and Z were properly used only in borrowed words, especially in those coming from Greek.

The reduction of the alphabet to eleven letters, normalized to A P C T E I R M N U S, as proposed for Bacon's cipher, does not produce such serious ambiguities as might be supposed. For *q* and *c* were only graphically distinct from *c*, and might be written *c* without detriment to intelligibility; so also may *cs* be written for *x*. The letter *h*, being silent in Bacon's day, may easily be omitted in writing; except that in the late spellings *michi* and *nichil*, for classical *mihi* and *nihil*, the *c* indicates the former presence of an *h*. *Y* was in Bacon's day sounded as *i*, and need not be distinguished from *i* in writing. With these substitutions, and *nicil* for *nihil* in its six occurrences, we have the following table of frequency per thousand letters, the slight alterations caused by turning *x* into *cs* and by omitting *h* changing the total slightly from the normal total of 1000:

Letter	Occurrences
I J Y	115.0
E	113.8
U V	95.3
A	92.7
T	78.0
N	71.0
S X	69.3
R	64.7
M	58.7

Letter	Occurrences
O	55.0
C Q K X	54.0
L	37.3
P	23.0
D	21.0
B	17.3
G	15.0
F	13.3

Total	993.9

The only real obscurities, then, in writing with Bacon's simplified alphabet, are those involved in using the same symbol for *o* and *u*, for *g* and *c*, for *d* and *t*, for *b* and *f* and *p*, for *l* and *r*. These make a total of but 159 per thousand. That the difficulties produced are not serious, may be seen from the rewriting of the opening sentences of Cicero's *First Oration against Catiline*, in Bacon's eleven-letter alphabet, with italics indicating the changed *o d g b f l*:

Cu*u* uscue tan*t*em a*p*utere, Cati*r*ina, patientia n*u*stra? Cuam *t*iu etiam *p*uror iste tuus n*u*s eru*t*et? Cuem a*t* *p*inem sese e*pp*renata iacta*p*it au*t*acia? Nici*r*ne te n*u*c-turnum praesi*t*ium Pa*r*ati, nici*r* ur*p*is uici*r*iae, nici*r* tim*u*r p*u*puri, nici*r* c*u*ncursus *pu*n*u*rum *u*mnium, nici*r* ic munitissimus a*p*en*t*i senatus *ru*cus, nici*r* *u*rum *u*ra uur*t*uscue m*u*uerunt?

The changes in this, which are just about typical (rate, 155 per 1000), are more noticeable to the eye than to the ear. In the eleven-letter alphabet, it might be added, the frequencies are as follows:

Letter	Occurrences
U	150.3
I	115.0
E	113.3
R	102.0
T	99.0
A	92.7

Letter	Occurrences
N	71.0
S	69.3
C	69.0
M	58.7
P	53.7

Total	994.0]

CHAPTER VII

The Script of the Shorthand Cipher

[As I have said, the first form of the cipher is the bogus Latin text, described in the preceding Chapter.] The second form of the cipher,[1] that used in the Voynich Manuscript, was devised, I believe, chiefly to diminish the difficulty of writing and reading. In it the superficial and spurious text is replaced by a superficial, spurious system of seemingly alphabetical symbols. At first sight the cipher seems to be composed in large part of letters of the Latin alphabet, the most common being *s*, *m*, *n*, *u*, *o*, *a*. A letter resembling a form of the Greek Theta is of frequent occurrence, as also are the flourishes carried above and below the line, [such as are] commonly used in mediaeval manuscripts as signs of certain abbreviations. In addition to these there are numerous signs not resembling letters of any known alphabet.

Closer examination however reveals that the apparent simplicity of these letters is delusive. The supposedly Roman letters in many instances diverge widely from the standard forms. Many of the variant forms might be taken as due to carelessness in writing, but many others depart so widely from the standard that this explanation seems forced. The same may be said of the cipher characters. I have found that all attempts to reduce them to a limited number of definite forms end in bewilderment. Like the Roman letters each seems to be fluid in structure, tending to shade away in imperceptible degrees into forms of radically different type. Furthermore, very many characters occur very seldom indeed in the entire manuscript. To construct an alphabet of such symbols is impossible.

[1] [Most of the text of this chapter is taken by permission from the unpublished text of an address made before the American Philosophical Society, at Philadelphia, on April 21, 1921.—RGK]

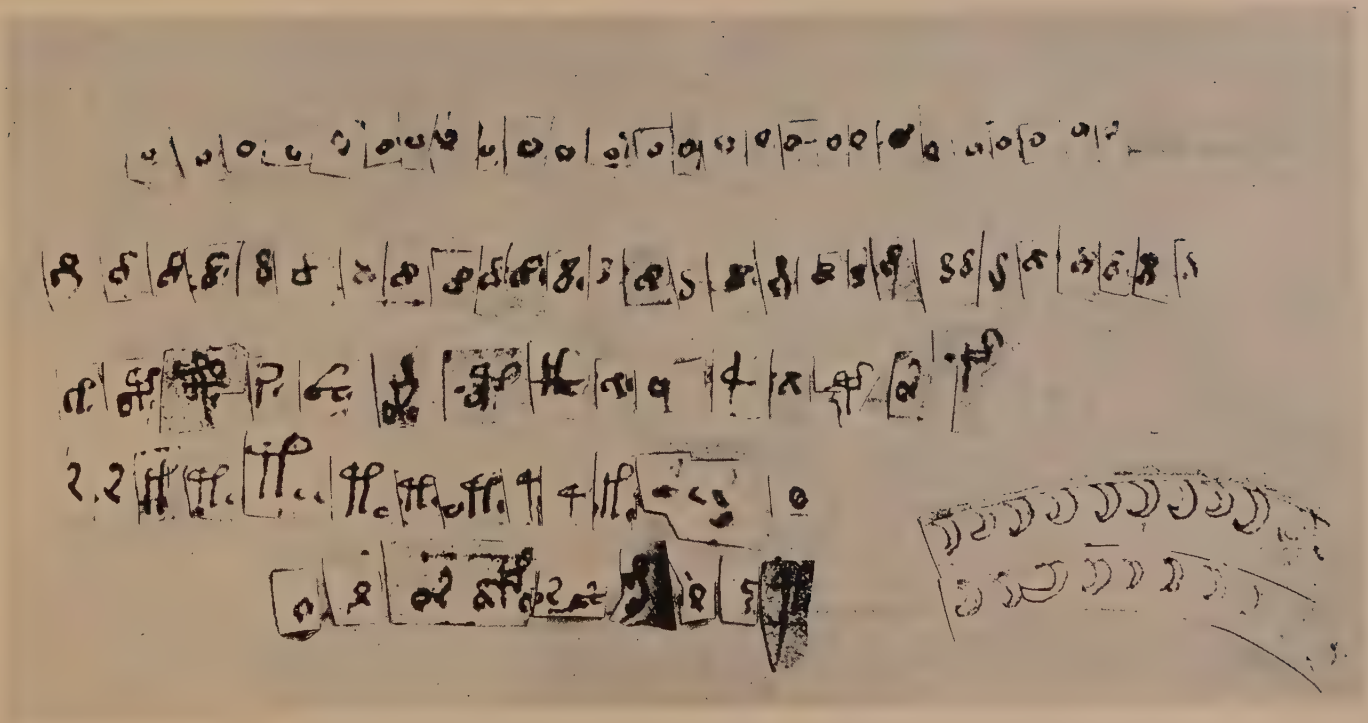


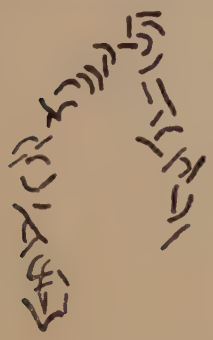
Plate XI
Characters in the Voynich Manuscript
(see explanation on page 97)

Examination of these characters under slight magnification brings to light still more puzzling features. These sloppy sprawling characters are not the work of a careless hand, but are composed of individual strokes of the pen, not mere dabs generally following the ductus of the hand, but placed with meticulous care, often quite at variance with that natural ductus. Sometimes they are straight lines placed at an angle to it, sometimes they are minute curves carefully inset into a series of other elements. The idea that the

Characters in the Voynich Manuscript

Specimens to show the variations and fluctuations mentioned in the text. Line 1, *o*-types; line 2, *s*-types; line 3, unique and nondescript types; line 4, characters with intrusion of extraneous elements; line 5, characters with extruded elements. In the hook-shaped characters at the right, note the variations in the lower tips. All these characters are composed of minute characters.

I attempted to read the first group in the last line and record the results as I got them without changing a letter. As I have no idea of the context I do not know whether it is right or wrong. But it *looks* plausible.



```
t i i v e o e h t e h t n b e p e t e i u t t-
A S I A N E M I T M I O E S I P L T U C S C
   C     L  P L  C    C E  P  M
                       L A     I

(t) p p i p t s i t p d u n e t u e s e i d e
    O O A I P C L I O N I N E L C N I L U E U
       L E C    L    E
```

```
A  S  Ic A  n  e  Ml                          A S I A M
N  E :  i  tp Ml I Oc e  S                    h O M I N E S
i  Tp E : Lic Pea R  tp O  Cmi S  c  o  o  Al  E C S P L O R A N T
I  tp Q  U  o :                               Q U I
tp U : Ie Pc C  L  Il O  N  ie N  E  R        I N  P E R I C U L O
Tp Ie : G  N  I  R  U  E  U                   V I G U E R I N T
```

characters were composed of significant elements was first suggested to me by the [apparent] *o* in *multos*, [the interpretation of which has already been given.] I drew the inference that the cipher characters might be monograms constructed upon the same principle, which

Explanation of Plate XII

Bacon's shorthand alphabet consisted of seventeen letters, namely those which are found in the secondary form of the Key Sentence *michi dabpqs nvultceqs portqpis* or *a b c d e h i l m n o p q r s t u*. The final letter is either *u* or *v*, no distinction between them being drawn. The forms of the shorthand signs are given in the accompanying Plate; the following notes will be found useful:

The sign for *a* is a straight line on or below the base line.
The sign for *b* is the lower left quadrant of the circle.
The sign for *d* is the lower right quadrant.
The sign for *e* is a slanting line running upwards at any angle to the base line, between 0° and 180°.
The sign for *h* is a shallow curve, opening to the right.
The sign for *l* is a narrow semicircle opening downward, with the center of the arc at any angle between 90° and 270°.
The sign for *m* is a compound curve, rarely found.
The sign for *o* may perhaps be also a heavy dot.
The sign for *p* is the upper right quadrant.
The sign for *q* differs from that for *c* only in being smaller.
The sign for *r* is the inversion of the sign for *l*.
The sign for *s* is a curve of any size, opening to the left.
The sign for *t* has four forms: a horizontal line above the base level; a shallow arc less than a semicircle, opening downward; the upper left quadrant of the circle; two dots in any position relative to each other.
The signs for *o*, *u*, and *n* differ only in length, and are often difficult to distinguish from one another.
The combination ∧ = *ne*, read from right to left, seems at times to have been used for *q*, which is its alphabetic value.

In reading the signs, it is important to read them in the proper order, or the resulting values will be changed. In general, one should begin at the lower left, and proceed upward following the ductus of the pen; at doubtful points a hair-line guide sometimes occurs.

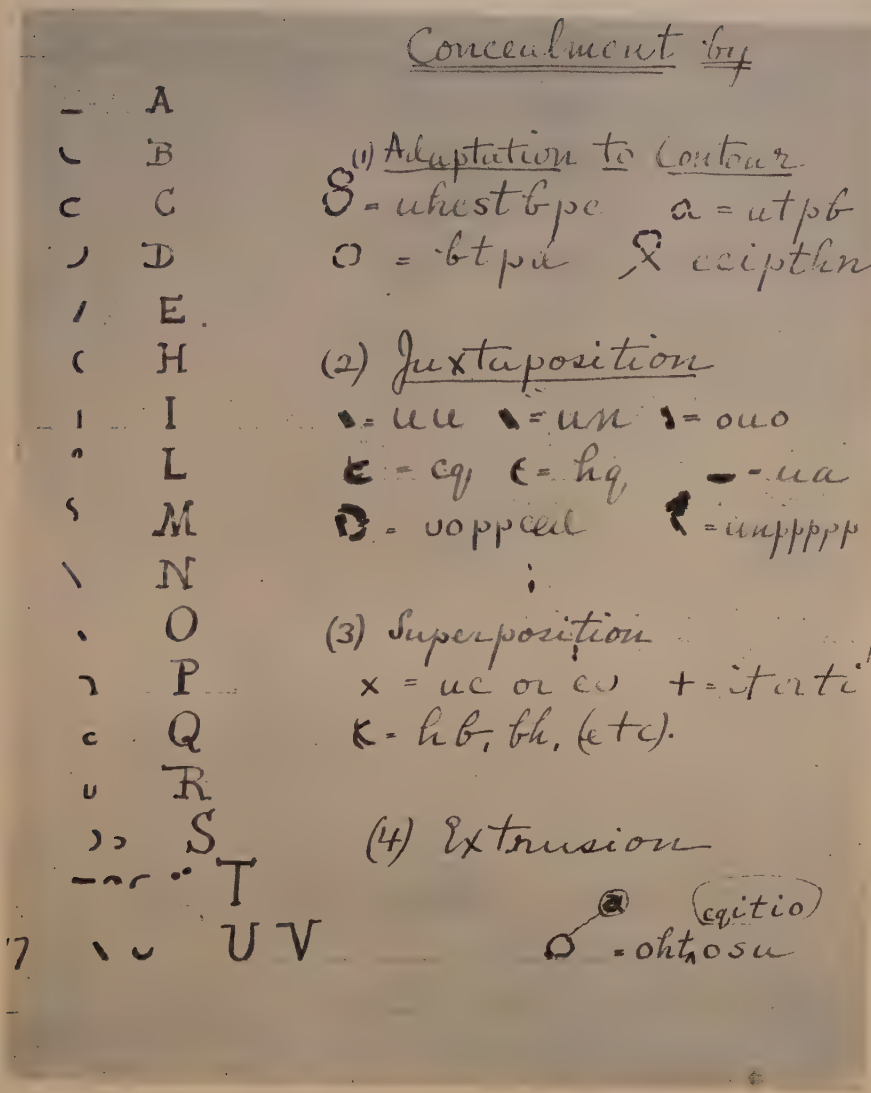


Plate XII
The Shorthand Characters of Roger Bacon and his methods of concealing them

inference was confirmed by the fact that Bacon in the *Opus Majus*[2] expresses the opinion that Chinese characters alone are constructed on scientific principles, because they are composed of significant elements.

I therefore made a list of these elements as best I could, and after searching long for their origin finally discovered it in the system of Greek shorthand current in the Middle Ages. But the characters are not monograms. Bacon's alphabet contains seventeen letters. One of these letters, *t*, is expressed by four symbols, and another, *u*, by two [symbols], a total of twenty-two signs. Fifteen of the twenty-two are derived more or less directly from Greek shorthand; the remaining seven seem to have been invented by Bacon himself. I have determined the values with a fair approximation of accuracy, but am not sure of all. Especially do I suspect that the additional symbols which I have assigned to *t* and *u* have independent values not yet detected. Out of these tiny letters Bacon builds up the characters of his spurious cryptogram precisely as in the original form of the cipher he built the spurious [Latin] text out of the biliteral symbols. As before, Bacon's own text is first converted by means of the uniliteral alphabet into a series of equivalent letters and for these letters biliteral symbols are substituted. But at this point he introduces a new entanglement never used in the original form of the cipher. For the original biliteral symbols an entirely different set is substituted.

These derived symbols may be reduced to their origins by the application of a simple "commutation" rule: Whenever any one of the seven letters *c o n m u t a*, which spell the imperative of the verb *conmutare* "exchange", occurs in one of the derived symbols, it changes the value of the adjoining letter. If it [i.e., any one of the

[2] I 374: *Cathai orientales scribunt cum punctorio quo pingunt pictores, et faciunt in una figura plures literas comprehendentes unam dictionem, et ex hoc veniunt characteres qui habent multas literas simul; unde veri characteres et physici sunt compositi ex literis, et habent sensum dictionum.*

The cryptogram characters, when written large, often resemble Chinese characters:

= eeehtsitttu = SSMICLICCC = MCCLCSCSII = MCCLXXII.

Probably Chinese documents shown him and explained by William de Rubruquis gave the suggestion which led to the invention of the cryptogram form of the cipher.

letters of *conmuta*] is the first letter of the symbol, it reverses[3] the second; if it is the second it converts the first. *Q* is treated as having the same commuting power as *c*. For example, in the symbol *te*, the *t* changes *e* to *i*; in *et*, where *t* stands in the second place, it changes *e* to *q*. If both letters are commuting letters, each commutes the other; thus *tq* must be read *pe*; *nt* must be read *mo*; and so on.

After the text has been translated into the derived [and commuted] biliteral symbols, they are strung together as before with identical finals and initials, the doubled letters being dropped; but no attempt is made to build out of them significant words. The only restrictions are those imposed by the shape of the spurious letters into which the tiny characters are to be introduced as components.

Bacon's favorite method of concealment is that of adapting the characters used, to the contour of the spurious letter which he is building. When he desires to introduce letters which cannot be concealed in this way, he has recourse to many other ingenious devices. If, for example, two letters when juxtaposed have adjacent boundaries similar in outline, they are written in contact, obliterating the interior boundary and simulating a single letter. They are often also superimposed one upon the other, again creating the illusion of a new character. But by far the most common device is that of reducing the letters in size below the limit of ordinary visibility so that they can be concealed more easily. Sometimes they are built into the body of a line, the series being concealed by a light wash of ink sufficient to obscure them without making them invisible. Sometimes they are thrown outside the line written in a compact mass and again concealed by a wash of ink in such a way that the whole resembles a blot. Bacon must have felt that this method of concealment was likely to be as effective as it was scientific, for there were at that time few if any men on earth besides himself who possessed a magnifying glass. Most of these microscopic characters can be read with a magnification of three or four diameters, but sometimes a higher power is required.

[3] [To *reverse* is to change according to the reversion alphabet; to *convert* is to change according to the conversion alphabet. See Table I of Chapter XX. The account in the text is adequate for deciphering; but for enciphering a prepared list of values is necessary. Thus *to* commutes to *pl* in deciphering, but *pl* also may stand in the cipher text; and one who is enciphering will have no reason to change *pl* to *to* before he uses it. This addendum to Newbold's account is essential.—RGK]

But it is not only in the construction of the bogus letters of the superficial text that Bacon used his tiny characters as an artist would use the strokes of his brush. Many of his drawings are built up in part out of the same elements. Frequently these in-written characters are distinguished from the non-significant lines by being made heavier, or by the use of blacker ink. I have not as yet found any in his drawings of plants, but they are extremely common in his drawings of human figures and of stars. Their decipherment is exceptionally difficult because of the uncertainty which attaches to the order in which the complex systems of lines should be read.

I have as yet attempted to read only a few of them. Those that I have read prove to be the names or the descriptions of the things represented by the drawings, or else are related to them in some similar way. Thus the four planets Jupiter, Saturn, Mercury, and Venus bear their names written in the lines of which they are composed. The features of two faces representing the sun and the moon, the measurers of time, give the dates on which the diagrams were composed; the Fleur-de-lys, symbol of life, contains the sentence *Vires velut multiplicant res materiales*; the crown on the head of a triumphant female figure is composed of the legend *Mundi, ecclesia, imperium tui*. This device, which through the medium of language constructs a picture out of the idea which the picture expresses, rests upon an ingenious combination of Kabbalistic and Aristotelian principles which I cannot now take the time to explain.

I have now given all that is essential to the understanding of the cipher, except the technical rules for the reading of the characters [and for the recomposition of the text; some of these I shall now give in connection with a statement of the difficulties of the work, while others must be left until I give the more formal statement of Rules for Deciphering the Texts, in Chapter VIII].

The values of the symbols are, I think, fairly well known. I have translated texts amounting to about 2500 words, comprising upwards of 15000 symbols,[4] and I regard the values of the more common symbols as approximately established. In the case of the bogus Latin, the only serious difficulty is that arising from the disarrangement of the letters of the underlying text. This is not intentional on Bacon's part; he tries to keep the letters in the original order, but disarrangement inevitably results because he uses

[4] [This was Newbold's statement in April, 1921.—RGK]

the symbols to construct a spurious text [which must give the appearance of grammatical correctness and of intelligibility of meaning]. The degree of disarrangement varies indefinitely. Often the text can be read with little uncertainty; but there remain many passages [or parts of passages] which may be recomposed in two or more different ways. It is, therefore, my opinion that while the general sense of the bogus Latin texts can be recovered with a fair degree of accuracy, a certain amount of doubt will always attach to most of it, and in some cases the doubt will be sufficient to impair in large measure the value of the translation.

In the case of the cipher manuscript, the difficulties are still more formidable, but that of recomposition, so serious in the case of the bogus Latin, is less serious. The text is not so much disarranged; in fact, the letters of many of the words are written consecutively without disarrangement. But the difficulty of reading the cipher characters is very great indeed. When first the letters were written they were, I think, distinctly visible under the proper degree of magnification; but after the lapse of more than six hundred years the writing on many pages has been so injured by fading, scaling, and abrasion, that the characters can scarcely be seen at all.

In the second place much depends upon the degree of magnification which was used [by Bacon at the time of writing]. The line which to the naked eye seems quite simple, when magnified three or four or five diameters is frequently seen to be composed of individual elements, and if [it be] magnified still further some of the elements will be resolved into still other elements many of which may be taken as characters. Bacon's friend, or friends, to whom the manuscript was entrusted, who no doubt possessed Bacon's own lens, would have found these difficulties of slight moment; but to us who have not as yet determined what degree of magnification he in each case used, the matter is of vital importance. My own experiments have convinced me that the lens [which] he ordinarily used was under ten diameters in power; for his characters, when magnified more than ten diameters, tend to dissolve themselves into formless masses of ink. But for his lower powers I am as yet without definite evidence.

Another very great difficulty is that offered by the elusiveness of the characters themselves. The differences among them are very slight; when they are written under a microscope, even Bacon's

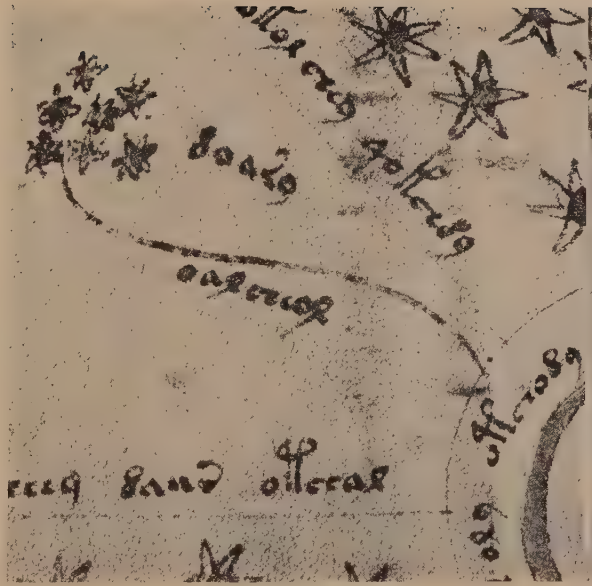


Plate XIII A

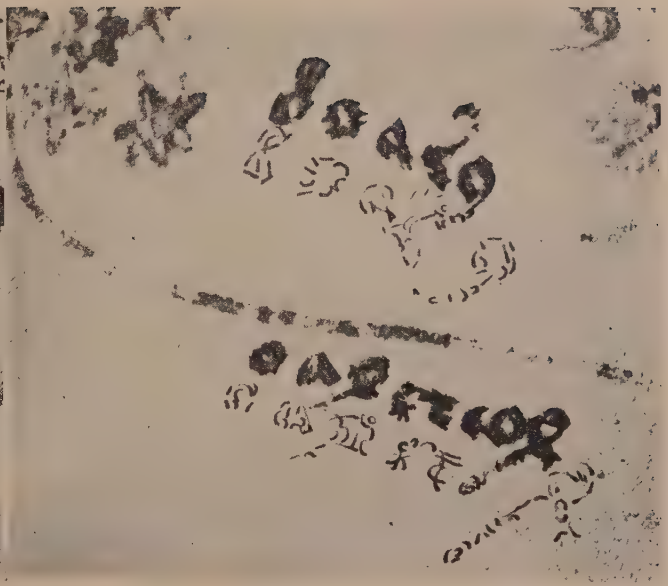


Plate XIII B

Part of folio 68 recto, in various enlargements: A is enlarged about two diameters, B about four diameters, and C about eight diameters. After a certain amount of enlargement the characters lose definition; but the drawings of the microscopic characters by Newbold in B look probable

Courtesy of Wilfrid M. Voynich

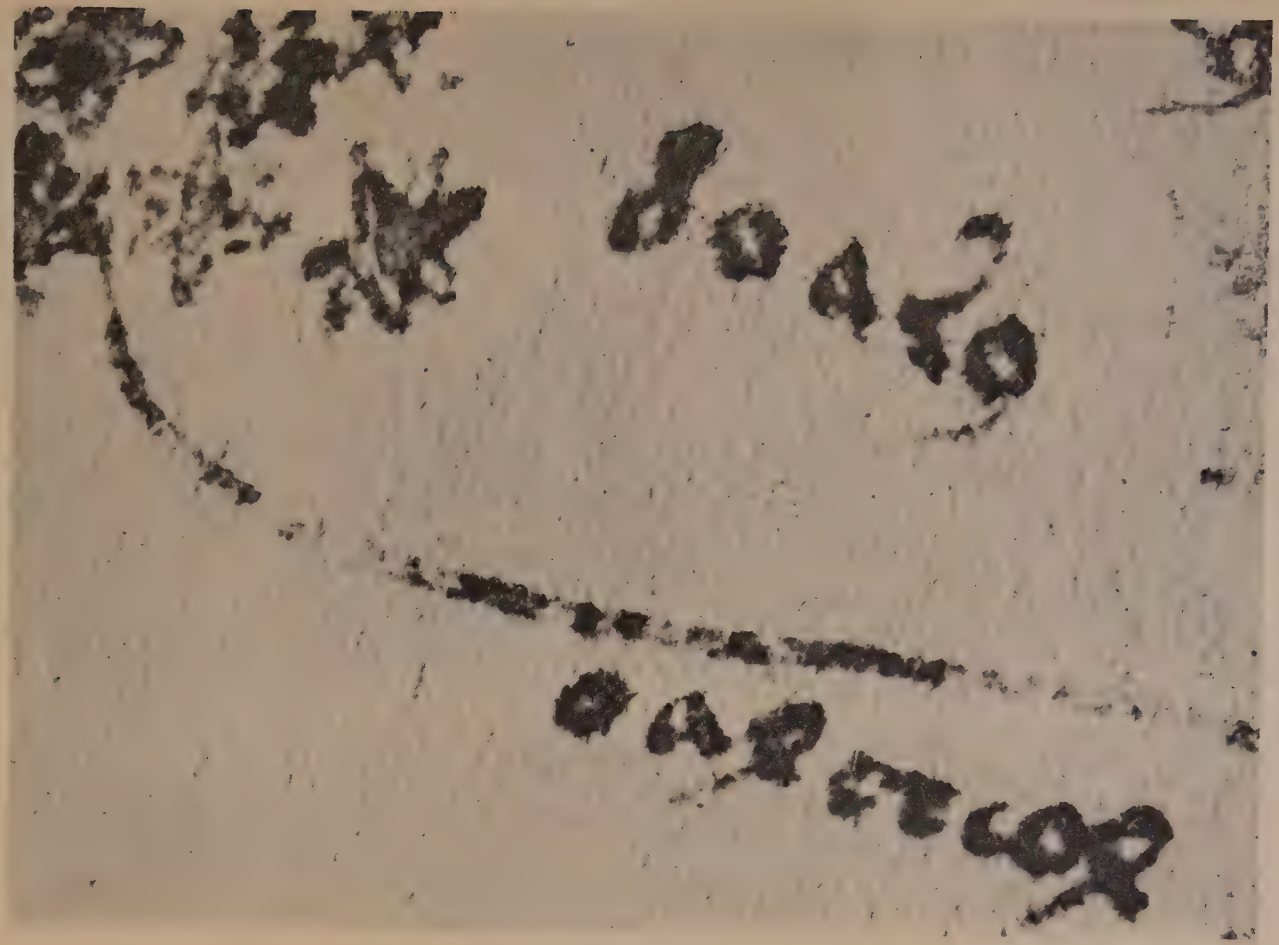


Plate XIII C

[own] hand often gives to the differences but faint and ambiguous expression. Furthermore the characters are so interwoven one with another that it is often all but impossible to disentangle them. The untrained eye, even with a microscope, cannot distinguish one from another, and to read them at all requires long practice and extreme care. After nearly two years of such practice[5] I am able to see distinctions which no one else can see, but even to my eye these distinctions are often of the most fugitive and elusive character. I frequently, for example, find it impossible to read the same text twice in exactly the same way.

I have made many experiments with the hope of being able to make these tiny characters visible to an audience by means of magnified photographs, but with rather disappointing results. In all of them the outlines of the characters, at best never too distinct, are so blurred as to make it difficult [or impossible] to distinguish them. The smaller characters are often resolved into a mere aggregation of ink marks; the larger are blurred by the running of ink into the crevices of the parchment or along its fibres, and by the accumulation of the ink salts into granular masses which are much more obvious than the outlines of the characters which they compose. The photograph [herewith presented] is perhaps the best that I have been able to make. Beneath it I have copied the characters as best I could. In making this reading I have used nearly thirty prints of varying degrees of magnification and development, and I have spent much time upon it, yet I am not quite sure that all the characters are correctly recorded. As regards the majority of them, however, I think there is little room for doubt, and if one compares the photograph with the characters as I have analyzed them, one can, I think, see at least that my readings are not purely arbitrary, that the majority of them faithfully represent the actual contour of the letters. If I have read them correctly, the values follow automatically, [and the only remaining task is that of recomposing the Latin from the disordered characters][6]. . .

[5] [Statement of April, 1921.—RGK]

[6] [The Plate gives a sample of this character. It is uncertain whether this is the actual series of enlargements referred to in the text, but the principle is not affected, as the exhibit is similar in character. After this, in his manuscript, Newbold mentioned several facts unknown to him but verifiable from outside sources, which he had read in the shorthand cipher texts. These are here omitted, since they are given in detail in Chapters X–XIII.—RGK]

I have no doubt that in all these texts there are many mistakes,[7] and much time must be devoted to their correction before they will be in proper shape for publication. I do not therefore present them as demonstrated facts, but merely, as I have explained, as the grounds for my conviction that the essential principles of Bacon's cipher have been recovered and that there is a fair prospect of overcoming the difficulties which at present make accurate and continuous reading impossible.

Finally, I would call attention to the means which in my judgment are most likely to overcome the difficulties [in the decipherment of the Voynich Manuscript]. The first readings should be made from unmagnified photographs focussed as definitely as possible; a lens [with a magnifying power] of about eight diameters should be used [by the reader]. These first readings should be made independently by two or more individuals, results [should be] compared, and agreement [should be], if possible, reached. These readings should then be verified by comparison with the Manuscript itself. Nearly all my own work has [unfortunately, and of necessity,] been done from photographs. On the few occasions on which I have been able to examine the Manuscript, I have found it much more easy to deciper than the photograph, the color of the ink being of great assistance in distinguishing the characters from mere discolorations. I believe that several scholars working together will be able to devise a technique by means of which the text can be transliterated with approximate accuracy. If that can be done, the difficulty of recomposition will rarely be of serious import, and we shall be able to recover the record of what are, I venture to think, the most extraordinary achievements in experimental science ever made unaided by an individual solitary genius, and we shall be enabled to restore that genius to the position which he deserves to occupy in the history of human achievement.

[7] [This refers to the texts given in the omitted part of the lecture, and mentioned in the preceding note. In fairness to Newbold, attention must be called to the fact that he wrote this in April 1921, and that he had afterward ample opportunity to revise and correct these documents.—RGK]

CHAPTER VIII

Rules for Deciphering the Texts

[For the deciphering of the Latin texts,[1] four processes must be applied:

1. Syllabification: [double all but the first and last letters of each word, and divide the product into biliteral groups or symbols.]
2. Translation: [translate these symbols into their alphabetic values.]
3. Reversion: [change the alphabetic values to the phonetic values, by the use of the reversion alphabet.]
4. Recomposition: [rearrange the letters in order, and thus recompose the true text.

The second and third processes may be reduced to one by assigning the phonetic values directly to the symbols, by the assistance of Table VI in Chapter XX.

These directions may be made more explicit, and the technique of recomposition made clearer, by the following formulations:]

A. The spelling, both of [the superficial or upper text, which we may call] Text B, and [of the true or under text, called here] Text A, is that of classical Latin,[2] with which the Greek Grammar [written by Bacon] shows Bacon to have been familiar. Mediaeval corruptions never occur, and abbreviations are rare.

B. Spell *x* [by] *cs*; double all the letters of each word except the first and the last; the resulting pairs are the biliteral symbols. [Thus *doctrina* = *do oc ct tr ri in na*.]

C. Assign them the phonetic values of Table VI, [which skips the translation into alphabetic values], regarding those written [there] in capitals as the only ones ordinarily to be considered; though in a pinch Bacon may use others, [given in minuscules in Table VI.]

[1] [The Chapter is prepared from some explanatory charts and from a copy of a letter written on February 12, 1920, as well as from some other miscellaneous papers.—RGK]

[2] [This needs some limitation. Newbold spells *almost* always in the classical style, in his reconstructed texts; especially, he normally writes *ae* and not *e*. But one finds *phenomena* and *sphera* for *phaenomena* and *sphaera*, and *spacia* for *spatia*. There may be some other variations from the classical norm.—RGK]

D. [Now rearrange the letters; for the easier performance of this task] Bacon endeavored to leave in Text B [words which would produce] letter-groups distinctive of the words to which they belonged, more easily recognizable to a mediaeval scholar, who virtually always read his Latin by means of abbreviated letter-groups, than to modern readers of Latin, except palaeographers. Therefore

(a) Look for such groups down the line; take out the most probable word near the head of the line; close up the superfluous letter; repeat the process.

(b) A letter lacking in a word should not [necessarily] be supplied by taking the next occurrence of the letter, as that occurrence may be needed where it stands; wait until it is found where it is redundant.

(c) Usually a multiple should be used where it stands, but there are some exceptions.

(d) Exceptions to the letter-group rule are: (i) Words composed of such groups, e.g., *doctrina* = E-C-N-O-N-T-MS, which is used to write *necnon*, but is not reserved for it. (ii) Small words, which necessarily often occur as parts of larger words. (iii) Occasional accidental collocations of letters.

(e) Small words, especially conjunctions and prepositions, are often buried in a large adjacent word at some distance from the place where they belong.

(f) Numerals are sometimes spelled out, sometimes written in Roman numerals.

(g) The only indication that the recomposition is correct is the regular appearance, at intervals of not more than three or four words, of letter-groups suggesting words appropriate, in syntax and logic, to the preceding text. If they fail to appear, if one is driven to arbitrary choice in order to make sense, the recomposition is probably wrong.

[For the reading of the cryptogram or shorthand texts, there are not four, but six processes in the interpretation:]

1. Transliteration: [identify the shorthand characters and transliterate them in order.]
2. Syllabification: [double all but the first and the last character, for there is no word-division; and arrange in biliteral symbols.]

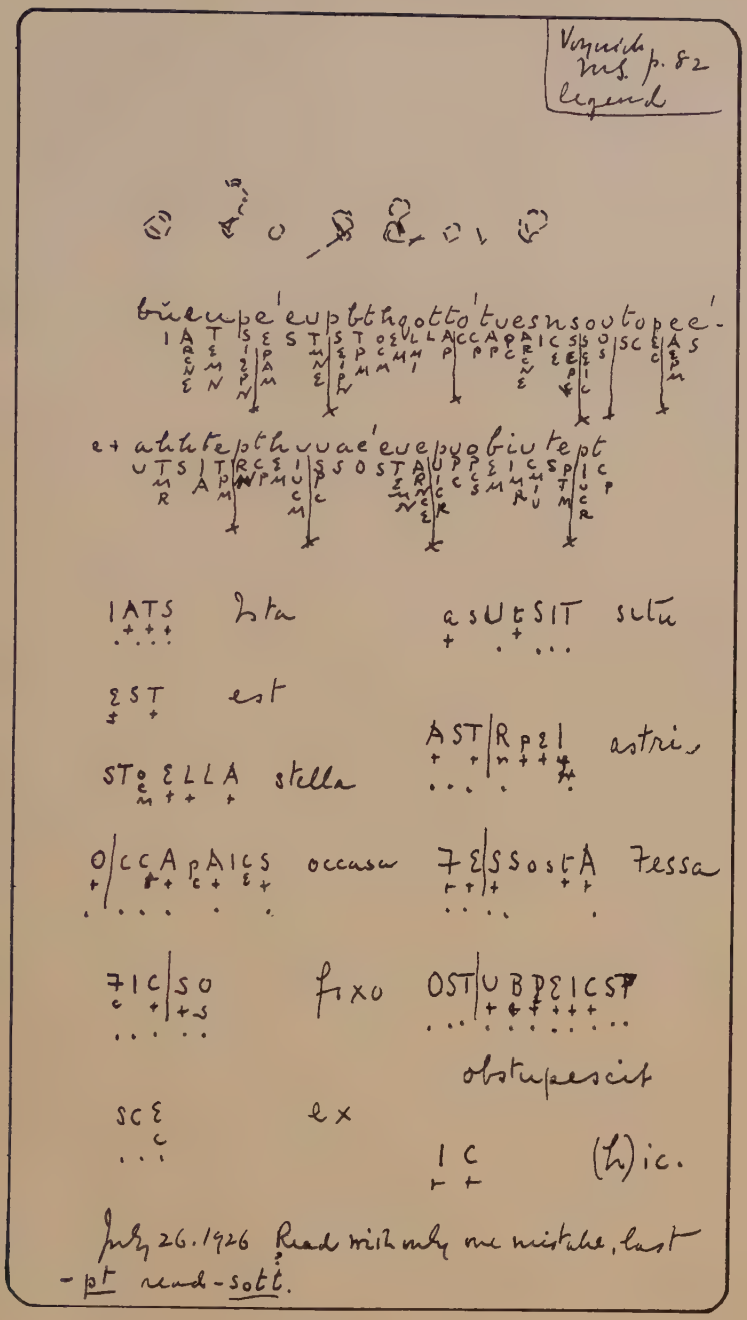


Plate XIV
Newbold's Last Finished Worksheet

3. Commutation: [in any symbol where the second letter is a commuting letter, namely *c o n m u t a* and *q*, change the prior letter by the conversion alphabet; where the first letter is a commuting letter, change the second by the reversion alphabet; where both are commuting letters, change both in the ways just stated.]
4. Translation: [assign to the commuted symbols their alphabetic values.]
5. Reversion: [change the alphabetic values to the phonetic values.]
6. Recomposition: [rearrange the letters in order, as with the cipher Latin.]

[But this process may be much shortened, by assigning directly to the biliteral symbols reached in the second process the commuted phonetic values given in Table IX of Chapter XX.]

[Thus after the values of the symbols is established, there are but two difficulties: in the shorthand text, that of reading the signs at all, and of reading them in the correct order, since an error in the order produces two errors; in both kinds of text, that of recomposing the letters correctly. The technique of this has just been described in connection with the interpretation of the Latin form of the cipher; and in fact] the element[3] of doubt introduced by the necessity of recomposing the anagram is not, I think, as great as it might seem to be. When I succeed in hitting the clue early, the way it comes out is very impressive, to me at least. I keep on constructing new words and carrying over a residuum of unmanageable letters until I get near the end; then I discover that the last group of letters not only makes a word, but makes just *the* word needed to complete the sense. In case of the above anagram,[4] which contains 139 letters, I at first made the mistake of trying the form *Oxfordia*[5] for Oxford, and so came to grief when I got towards the end; but as soon as I corrected that blunder it all came out smoothly. Of course I often make mistakes reading the cipher characters and have endless trouble correcting them, but in this case I have not changed a letter of my first reading.

[3] [The remainder of this paragraph was written on February 12, 1920.]
[4] [That pertaining to the annular eclipse of 1290; see Chapter X.]
[5] [Instead of *Oxonia*; both, of course, actually with *cs* for *x*.]

CHAPTER IX

The Interpretation of the Key

The Key [itself,[1] of which a photographic representation has been given in Plate X, is most ingeniously constructed, for it] contains two texts, the superficial (B) and an underlying (A), [the latter] reached through the cryptogram characters out of which the visible letters are built.

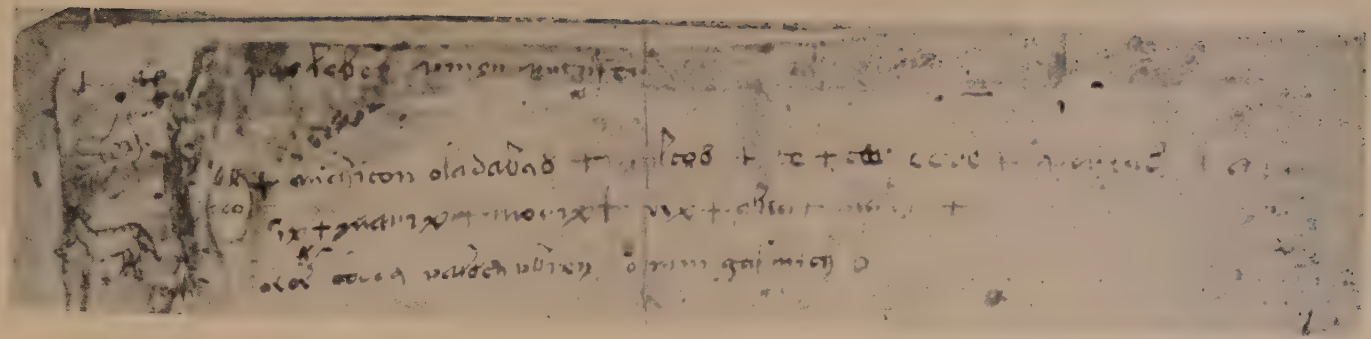
Text B comprises two sections, (1) *Michi* to *portas*, containing the Key sentence with the interpolations, (2) from that point to the end, written partly in Roman and partly in cryptogram characters, in which the alphabetic values are spelled out in terms of the biliteral symbols. It must have been intended for the use of some trusted friend who had been taught orally how to read it,[2] and every device has been used to make it unintelligible to any unauthorized person. For example, here and here only the alphabetic, not the phonetic, values are used; the mode of spelling them[3] varies arbitrarily from two to five letters, and Roman and cryptogram characters are used indiscriminately. I do not understand all of it, and the explanations given are probably in some cases mistaken.

[Even hasty examination of the Key shows that the apparent letters are of peculiar shapes, not to be explained by mere chance. In Chapters V and VI an explanation was given of the special forms of the second *a* in *dabas*, of the *m* and the *a* in *multas*, and of the *a* in *portas*. That some similar values underlie the other peculiarities can hardly be doubted. A transcript of the Key from this standpoint is therefore given, in which numerous shorthand or cryptogram signs will be observed. By reading them out in plain letters, with the omission of a few extruded elements which are reserved for later discussion, the following is secured; disguised letters are shown by italics:]

[1] [This Chapter is based on papers and charts of varying kinds, covering all the materials here presented.—RGK]

[2] John?—cf. the new *Frag. Op. Tert.* Duhem p. 184; Little, p. 82.

[3] [That is, of spelling the alphabetic values:] two, *mo*; three, *tna*; four, *sics*; five, *m tiuq*.



+ michiton oladab[illegible]š + nvult[illegible]s + te + tĉcr cerc + port[illegible] + m[illegible]

six + marix + mo[illegible]ix + v[illegible]x + ahta + n[illegible]a + rict +

o[illegible] o[illegible] t[illegible]cuuq ualst[illegible] ubr en so nim gaf mith o

(1) michiton oladab*pqqoea nv*ult*ceq*s te tccr cerc port*qpipbpsetticlsd* m*tiuq*
(2) six *t*narix mo*hq*ix v*nt*x ahta n*na* rict
(3) o*utloudpttkg* t*dttcur*q ualst*rtl* ubr en so nim gaf mith o

Plate XV
The Key and its Transcription
Courtesy of Wilfrid M. Voynich

(1) michiton oladab*pqqoea nv*ult*ceq*s te tccr cerc port*qpipbpsetticlsd*
m*tiuq*
(2) six *t*narix mo*hq*ix v*nt*x ahta n*n*a rict
(3) o*utl*o*udpttkg* t*dttcur*q ualst*rtl* ubr en so nim gaf mith o

```
                                                        m
m i c h i t o n   o l a d a b a s   n v u l t o s
   cs pe on     to on     ol la          pq qo ea              ce eq
      s-t       s-l       i-q            i  i-o                t-b
   o   c         R         B                 a                  a

         t e   t c c r   c e r c   p o r t a s
          A      C    O     N    I              qpi
         ------------------------------        qp pi
         t e   t  a   r   ce   rc.             o-a
                             t -- i              a
         τέτ(τ)αρα = quatuor      a
```

[In this, the first part of the Key as Text B, the superficial text, one may recognize

(a) The Key Sentence in its short form: *michi dabas multas portas*.
(b) The Key Sentence in its expanded form: *michi dabpqs nvultceqs portqpis*.
(c) The cipher for *R. Baconi*, in the interpolations: *ton ola .. te tccr cerc*.
(d) The cipher for the Greek τέτ(τ)αρα = *quatuor*: *te tar cerc*; since *cc* is written so as to be readable as *a*.
(e) The alphabets of biliteral symbols:

```
Primary 1:  mi ci to no la da ba sm ul ta sq ua tu or po rt as et
Primary 2:  mi ch it on ol ad ab as mu lt as qu at uo rp or ta ti
Secondary 1: mi ci to no la da bp qs nv ul tc eq sq ua tu or po rt qp is et
Secondary 2: mi ch it on ol ad ab pq sn vu lt ce qs qu at uo rp or tq pi ti
```

Note that the shorthand signs above *ch* in *michi* stand for *pe-on* = *s-t* = *c*, so that *michi* is changed to *mici*; this explains the difference between first and the second biliteral alphabets.[4] In the shorthand signs which make up the *s* of *portas*, the central ones are *et ti*, which

[4] [But the significance of the substitution of *cs* above the *i* of *michi* and of *qoea* above the *s* of *dabas* is not clear to the Editor.—RGK]

motivates the differences in the endings of these alphabets; the signs are given in the next detailed exposition:]

```
s                  m  ti  uq   s i x   t  n  a  r  i  x   m o h q i x
pb ps et ti cl sd  m   s--q    si cs    tn na    ri  cs   mo  hq i cs
 a-c   B A   o-a   m----i       o-o      t-o      u-o     mo   t-i  u
  B           A     O, U         T        S        R       Q     a---u
                                                                   P

vn  t  cs   ah ta   nn  a   ri  ct   ou tl  ou dp  tt kg  td tt  cu rq
 q  t--o     q-i     l--a    u--m     t-c    l-c    r-t    a-t    p i
 q---s
  O           N       M       L        C      I      B      Q     P I

ua ls tr tl   u  b  r . en  so  n  i  m   g  a  f   m  i  t  h  o
 q  i  t  c    ub br     a   b   ni im     ga af    mi it it th ho
                q-b               q-o       a-m      a-b   b-u   e
 Q  I  T  C     B       A   B    I         O        O     A     E
                                   \_____/
                                      E
```

[It is obvious that these alphabetic values give in reverse order the uniliteral alphabets which are set alongside the series of biliteral symbols, as was explained in Chapter VI.[5] These begin in the succession following *et ti*, among the shorthand signs making up the *s* of *portas*. Take also *io*, near the end, as alphabetic B, and the correspondence with the alphabets is closer.

A tabulation makes this evident. In the following, the first line contains the values given in the Key. The line labeled P2–3 gives the alphabetic values of Primary Alphabets Nos. 2 and 3; that labeled P1–4, gives those of Primary Alphabets Nos. 1 and 4; that labeled S2–3 gives those of the Secondary Alphabets Nos. 2 and 3; that labeled S1–4 gives those of Secondary Alphabets Nos. 1 and 4.

```
KEY :     A U T S R Q P O N M L C I B Q P I Q I T C B A B B O     : KEY
P2–3 :     a u t s r q p   n m l c       p i   i t c b a           :P2–3
P1–4 :       u t s r q p   n m l c     q     q i t c b a b         :P1–4
S2–3 :   a o i t s r q p o n m l c i     p i   i t c b a           :S2–3
S1–4 :       u t s r q p n o m l c   b q     q i t c b o b b       :S1–4
```

[5] [There seems to be a few errors in the data of the manuscript from which this interpretation of the Key is taken. The Editor is not prepared to change them—for the errors may be his own rather than Newbold's—but he wishes to suggest some emendations: In the second line, *td* does not equal *a*, but *m* or *u* or *q;* and *mt* has the alphabetic value *c*, which is but another form for *q*. The *rq* at the end of the second line,

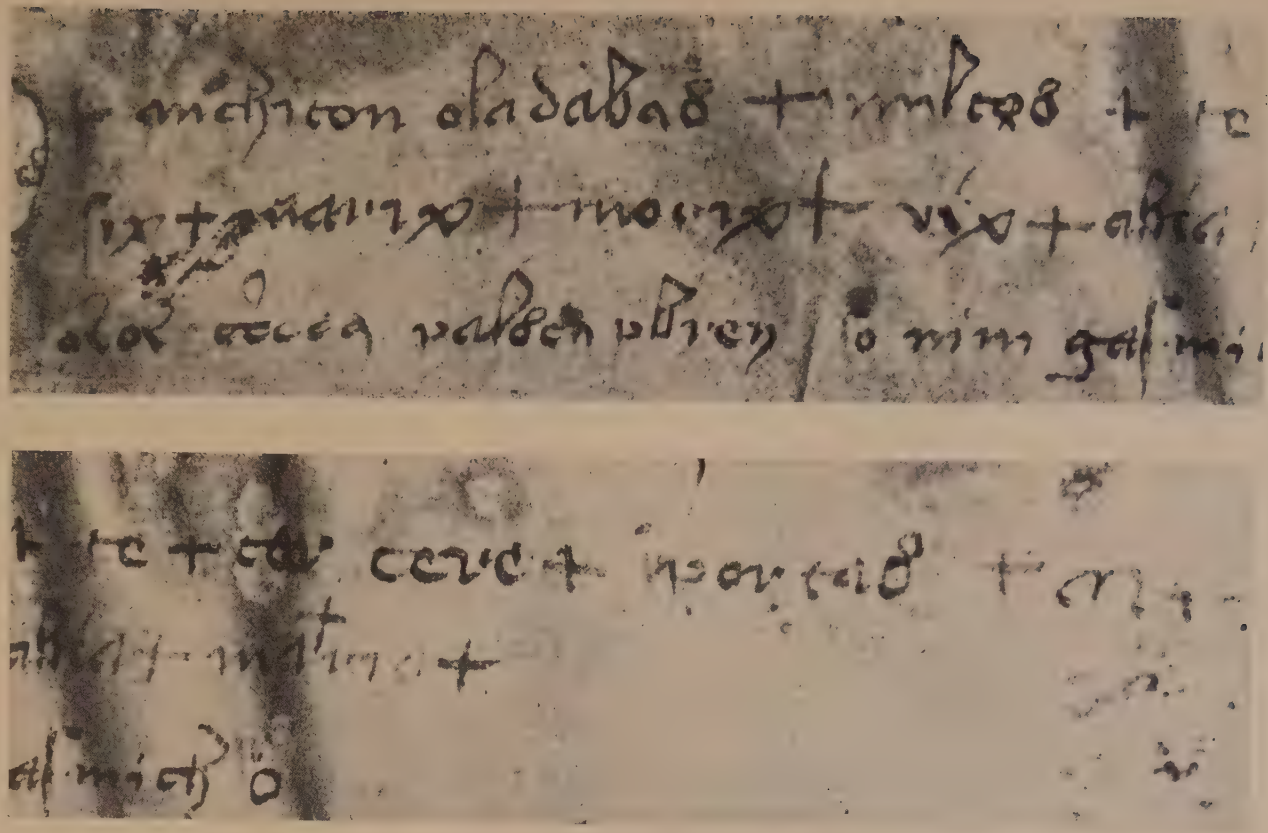


Plate XVI
The Key, enlarged
Courtesy of Wilfrid M. Voynich

Apart from the two transpositions in S1–4, everything is in the order given by the Key; except at the beginning of S2–3, where a scrutiny will reveal justification for *o i* instead of *u*. The curious omissions in the central sequence I B Q P I Q may be understood by putting the six letters in a diagram:]

```
I P I
B Q Q
```

[and reading them in the order of the original: it is not necessary to proceed diagonally at any point; but the values in the upper line include all those found in P2–3 and S2–3, and those in the lower line include all those found in P1–4 and S1–4. Moreover,] at the point where the divergences between the alphabets are recorded, a bunch of microscopic characters in red ink running up into the line above, gives an explanation which I have not been able to decipher.

[In the final sentence, *so nim gaf mich o*, *gaf* is not the proper form for the second singular of the preterit in English of Bacon's time, nor is *mich* the dative of the first personal pronoun. In the interpretation which has just been presented, *mich* has been read *mith*, since *c* and *t* were very much alike in form in the writing of the time, and while *mich* suggests the *michi* at the beginning, *mith* is needed for the interpretation here, and the double possibility is useful in the same way in which *tccr* in the first line may be read *tar* also. But perhaps the language is not so inexact as has been suggested:] a blot at the foot of the *f* contains characters which probably should be read [*aptn*, interpretable on the alphabetic basis as] *-est*, in which case one should read *gafest mi*, which would be more appropriate to Southern English of the thirteenth century. But the characters are so illegible that this remains uncertain. The final *o* remains unexplained, [although it serves a value in still another interpretation of the final sentence:]

```
so on ni im mg ga af fm mi it th ho
 B  T  Q  N  A  A  O  I  P  C  M  E  -  B A C O N  F A C I T  M E
 1 10  3  5  2  7  4  9  6  8 11 12     1       5 6       10  12
```

[Thus the final sentence, as part of Text A, has three readings:

---

with the shorthand sign for *r*, will not yield alphabetic *i* unless the *q* be taken as *c*; *rc* means *i*, and so also do *uq* and *vq*, if the prior sign be read not as shorthand *r* but as ordinary *u* or *v* or as shorthand *u*.—RGK]

the direction to use the Key Sentence; certain alphabetic values; a statement of Bacon's authorship.]

The Text A of the Key, an underlying text reached through the cryptogram characters out of which the visible letters are built, gives a brief account of the cipher. It contains about two hundred words. My translations were made from poor photographs, and undoubtedly contain many errors; but the fact that they contain words at the time unknown to me, and present the cipher from a point of view entirely foreign to my preconceptions, difficult to catch and yet not essentially different, leads me to believe that they fairly represent the general sense.[6]

There is also a line [of writing] at the upper margin of the page, of which the B-text seems meaningless (but I have made no special effort to decipher it); its A-Text contains about fifty words supplementary to the longer text in the Key itself, [and is discussed at the very end of this Chapter.

The signs in the A-Text of the Key are about thirteen hundred in number. They are to be read by the regular principles for the shorthand cipher; that is, by the phonetic values of the commuted symbols. The materials for the study of this text are all given in the latter portion of this chapter; but first a translation of the decipherment will be presented:][7]

"I, Roger Bacon, have written this.

"The Sentence[8] is to be set over against the individual letters. Join one letter to another without discrimination, uniting first to last. That they may all be matched up with the others, lines are

[6] [Newbold wished to revise his readings and interpretations thoroughly before making them public, and in fact left an uncompleted pencilled copy of the revision. This fortunately contained facsimile drawings of the groups of microscopic signs, which have been copied and presented here in plates. It should be noted, however, that Newbold never quite finished this revision, and consequently some errors still survive in his latest draft; an occasional symbol was omitted in the drawing or in the transcription (one cannot say in which the error lay), an occasional symbol was occasionally omitted in the assignment of values, an occasional symbol was wrongly translated. But these errors are few in comparison with the total, and would in all probability cancel each other, substantially.—RGK]

[7] [Newbold had precise interpretations for even the minutest detail; but some of these escape the Editor. Unclearness should be charged to the Editor and not to Newbold.—RGK]

[8] [The Sentence is *michi dabas multas portas.*]

helpful, drawn from the tips of each letter to the bottoms of the letters in the next row, so that none be omitted; and there are counted up four hundred and eighty-four[9] pairs. Taking out those which you see are neighbors,[10] change all the others;[11] see that you disregard none. From this procedure come the letters which those use who are called the most excellent sages, in the cabalistic volumes, in secret fashions, whose success has impelled others to make investigation.

"After I weighed the general considerations, I found several methods of hiding secrets. I considered all the languages which I had learned; in some I found letters with a dot in the center,[12] that were to be taken overlappingly,[13] doubled. When every biliteral group has been set down overlappingly, let every second letter be omitted unless it is final; let such final letter be kept. When those letters have been deleted, the 484 biliteral groups will be reduced to half.

"Omit every second letter, then double them again. Different meanings are assigned to the different groups, for each of the letters—meanings of which each and every one is indicated by the letters in *michi dabas* and the rest. You can find them by the twenty groups which form the Key, which, binding as it were those meanings to those letters, set their meanings upon them.

"I used to make alchemical formulas without sense, that they might beguile the stupid and ignorant. But in this document I have not used this fancy, but I have accomplished a flight with Julius Caesar's wing:[14] the letters of *conmuta* in the prior position

[9] [Newbold here operates with the alphabet of 22 letters, as he did until just before his death, and not with that of 23; cf. Chapter IV, note 3.—RGK]

[10] [This is not very clear to the Editor, but seems to mean those pairs or groups which have by juxtaposition already received their values. This becomes somewhat clearer by looking at Tables III and IV of Chapter XX.—RGK]

[11] [That is, change those groups which have no values as yet, by the process of reversion, until they receive values. Cf. Chapter XX, Table V, Part 6.]

[12] [This refers to the *daghesh* placed in the center of a Hebrew letter to show either that it is not aspirated or that it is doubled. It is the second use which is relevant here.]

[13] [That is, once with the preceding letter and once with the following.]

[14] [Julius Caesar, if desiring to write with secrecy, used a simple cipher in which A became D, B became E, etc., as we are informed by Suetonius, *Julius* 56: *Exstant et ad Ciceronem, item ad familiares domesticis de rebus, (epistulae) in quibus, si qua occultius perferenda erant, per notas scripsit, id est sic structo litterarum ordine, ut nullum verbum*

change the second letter of that group; but on the other hand the first letters of such groups become, *or* remain, the usual Latin letters."

[The detail of the interpretation of the first few words is next given. The shorthand text is given in ordinary minuscules at the left, with "commuting" letters in italics. Above is the serial number of the character. Below is the value of the symbol in the phonetic alphabet of eleven letters; the value used in the interpretation is put in capitals, immediately followed by any alternative values not used;[15] the warrant for these values may be found in Table IX of Chapter XX. Under the value is the numerical position of the letter in the reconstructed text.[16] At the right is the reconstructed text, with numerical values placed alongside for easy verification. Remainders from each group are carried down to the next line and separated from the new symbols by vertical dots. When any letter of the reconstruction is to be found at a later place, this is indicated under the reconstructed word. Note that the remnants are very slight, provided we regard *Rogerus Bacon* as a single word rather than as two. To sum up, 66 letters of the shorthand, or 65 symbols, form 64 of the 66 letters in the reconstructed words; one letter only is left as a remainder, to be carried on, and two letters only must be sought and brought back from a later point.]

1				5			8	
q	s	*t*	p	i	e	e	*q*	
	R	Pins	*Su*	*Car*	I	S	Iu	1-7 S C R I P S I
	3	5	1	2	4	6	7	

---

effici posset; quae si quis investigare et persequi volet, quartam elementorum litteram, id est D pro A et perinde reliquas commutet. Newbold has a marginal note to his earlier version,] "Suetonius relates Julius used a cipher in which for each letter he substituted the one removed four places. I did not know this when I read this, but found it later in Bp. Wilkins' *Mercury*."

[15] [All values here given are in Newbold's manuscript, except where they are in italics.—RGK]

[16] [The assignment of positions to letters does not always agree with Newbold's arrangement, but is designed to follow even more closely than his, the order of the cipher text, and to eliminate as much as possible the displacement of the letters. For Newbold became more and more convinced toward the end of his work, that the displacement was less than he had previously assumed.—RGK]

```
8    10              15              20   22
q  q  r  e  u  p  q  t  e  i  d  p  n  e  b
   U  R  Re T  Es A  N  Pt U  E  Cm  C  E  S
   9  8  12    11          13    10       14
                                          8-14  R O G E R U S

                          22    24
                        :  b  e  c
T  A  N  Pt E  C  E  :     S  Ui          15-19  B A C O N
   16 19 15    17             18

            24                   31
          : c  t  p  i  s  e  n  o
T  E  E  S  :    N  U  A  I  Ar T  N      20-28  S E N T E N T I A
23 21 24 20      22    28 27    26 25

      31          35            39
    : o  e  q  s  t    e  i  b  t
U  Ar :    E  Ui R  Ipns Tp U  Rm Cm      29-39  V U L T  A E Q U A R I
29 33      34 36 38 39   32 30 31 35             [37 A is 42-43 uq]

39              45             50              56
t  u  u  u  q  t  s  e  l  i  u  q  e  c  p  p  e  h
   C  S  S  A  N  C  R  I  N  Ic A  U  I  N  U  Pe Rm
   43 40 51 36 42    45 41       46 44 48    50 49 47
                                          44-51  S I N G U L A R I B U S

           56          60       63
         : h  o  o  s  h  e  q  s
C  N  Ic N :    E  C  Np T  Rm Iu R       52-58  L I T E R I S
      53        55       54 52 57 56             [58 S is 79-80 bb]

               63       66
             : s  d  c  e
C  N  N  C  Np :    E  U  U                59-66  C O N J U N G E
59 61 64 65         66 60 63                     [62 J is 72-73 es]
```

[There will now be given, first, the summary of the shorthand characters in the Key, with their numerical position, an asterisk showing that the letter or character only somewhat resembles that which it is alleged to be; second, plates of the shorthand characters,[17] with means of identifying the place in the Key and in the transcription; third, a transcription of the shorthand text, with critical notes; fourth, the interpretation or deciphered text, of which a translation has already been given.]

[17] [Made from Newbold's own enlarged drawing of them.—RGK]

Summary of the Shorthand Characters

+	1- 9	C	249-257	*R	523-529	*UI	900- 907
M	10- 16	E	258-264	I	530-536	Q	908- 919
I	17- 22	R	265-271	X	537-560	U	920- 928
C	23- 25	C	272-277	+	561-575	A	929- 942
H	26- 35	+	278-283	V	576-581	L	943- 954
I	36- 37	P	284-293	I	582-594	S	955- 966
T	38- 40	O	294-304	X	595-614	T	967- 980
O	41- 45	R	305-322	+	615-630	*N	981- 991
N	46- 50	T	323-331	A	631-651	U	992-1004
O	51- 54	A	332-340	H	652-681	B	1005-1023
L	55- 64	S	341-359	T	682-700	R	1024-1031
A	65- 69	+	360-366	A	701-720	E	1032-1039
D	70- 78	M	367-389	+	721-736	N	1040-1058
A	79- 86	*H	390-398	M	737-753	S	1059-1083
B	87-103	S	399-409	A	754-765	O	1084-1089
A	104-107	I	410-413	+	766-771	NI	1090-1104
S	108-119	X	414-424	R	772-779	M	1105-1118
+	120-131	+	425-437	I	780-787	G	1119-1139
MU	132-142	M	438-455	CT	788-797	A	1140-1155
L	143-161	A	456-467	+	798-814	F	1156-1184
TO	162-177	R	468-470	O	815-823	M	1185-1200
S	178-193	I	471-474	?	824-834	I	1201-1209
+	194-204	X	475-488	O	835-842	TH	1210-1256
TE	205-217	+	489-498	?	843-853	O	1257-1280
T	218-225	M	499-514	/	854-880	?	1281-1300
AR	226-248	O	515-522	TC	881-899		

[Transliteration of the Shorthand Text:]

1- 40	qstpi	eeqqr	eupqt	eidpn	ebect	pisen	o*e*qst eibtu
40- 80	u uuqts	eliuq	ecppe	hoosh	eqsdc	etibt	qesbp tsqbb
80- 120	b etpib	ubhqq	uhepn	peeha	eqnbt	uuash	tequu qbtse
120- 160	e qqpuq	hurqt	nltds	ipiit	ppqqs	uiihs	uulbp stlte
160- 200	e suabt	ttlup	oeeul	ppppb	hlsls	tlbot	usdos tespp
200- 240	p nstte	qqlud	tqqeo	basit	oeqet	baqtt	uteuh batqu
240- 280	u qitue	iooeq	eapsc	ttauu	rttpr	iuruh	huuut phi*b*q
280- 320	q stntt	epphc	qdpoh	ureeu	ttpae	ttibe	pl*c*to *b*ptee
320- 360	e tquot	uitee	tucsq	tqile	apltr	lssle	eqeqt eequi
360- 400	i peppt	tatel	eelet	ldetq	s*e*tu*p* u*s*aus		hulei qetqe
400- 440	e etuus	thoeq	eutae	etdlb	nueuq	eteep	qtetp pittt
440- 480	t boltt	suste	rqqib	aiace	eiteb	uiihi	etiee eetep
480- 520	p seeah	npt*b*u	ttbis	tequi	tssht	tqees	hspat oputo
520- 560	o *r*leuu	oeoqt	sieol	oqeqe	oeroh	ohneq	peuis loeti
560- 600	i uppat	seqoe	utetn	*asnt*d	ilppp	curct	lqqqt eeelq
600- 640	q pttot	tql*b*u	otupa	uoiun	losiq	tcpsc	uqeql tteso
640- 680	o ttpte	tppaq	apoeq	ttneo	ttupe	spbti	oslbe ubqst
680- 720	t odtcm	tso*r*i	tipue	etnuu	aoios	qscto	pplt*e* otmaa

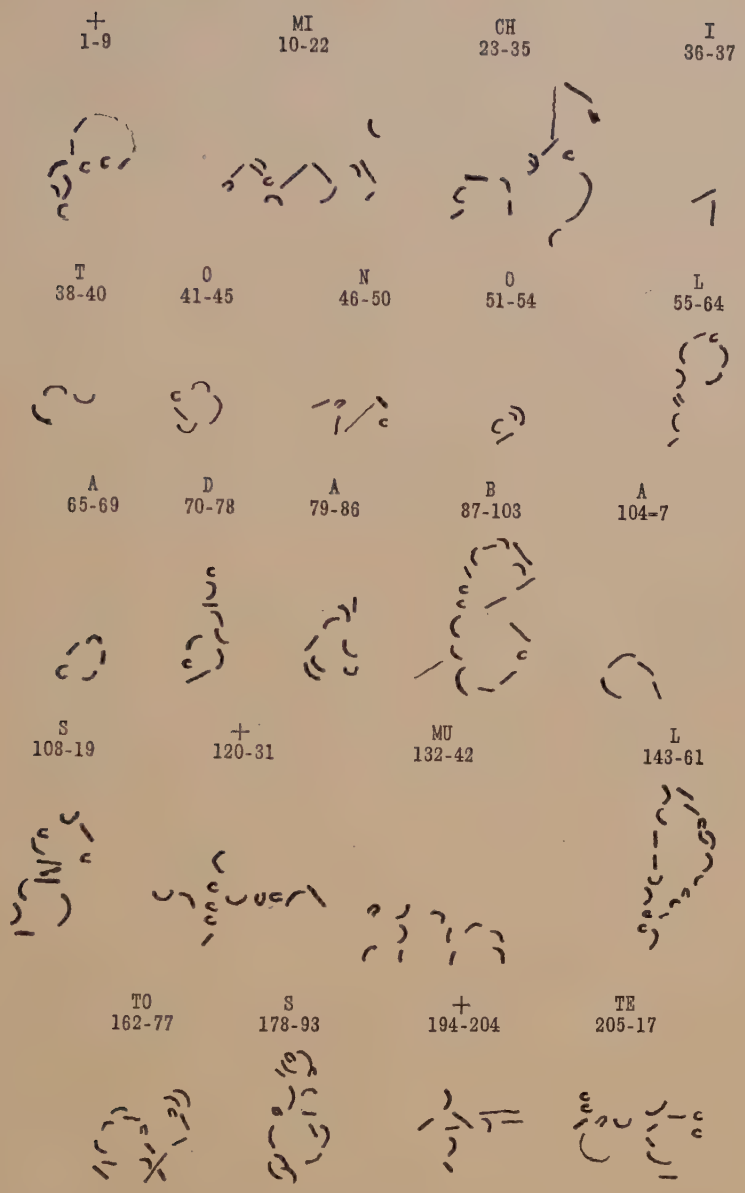


Plate XVII A

The Shorthand Characters in the First Line of the Key: first part

[facsimile of Newbold's drawing]

Plate XVII B

The Shorthand Characters in the First Line of the Key: second part

[facsimile of Newbold's drawing]

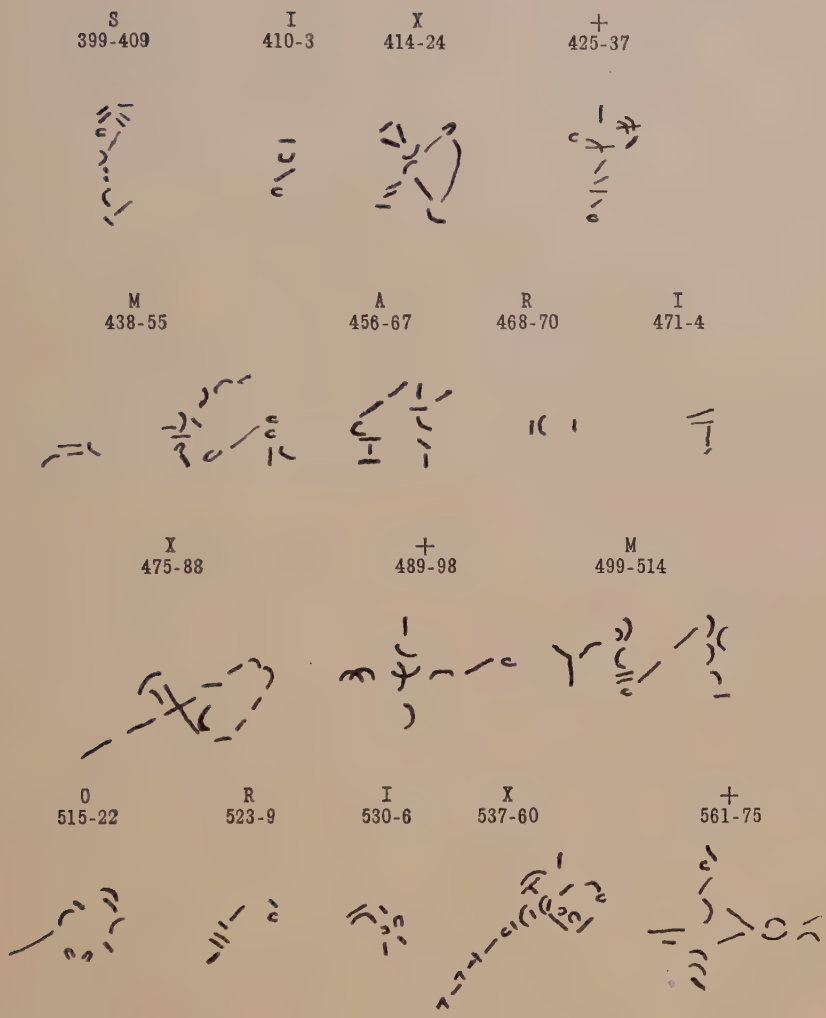


Plate XVIII A

The Shorthand Characters in the Second Line of the Key: first part

[facsimile of Newbold's drawing]

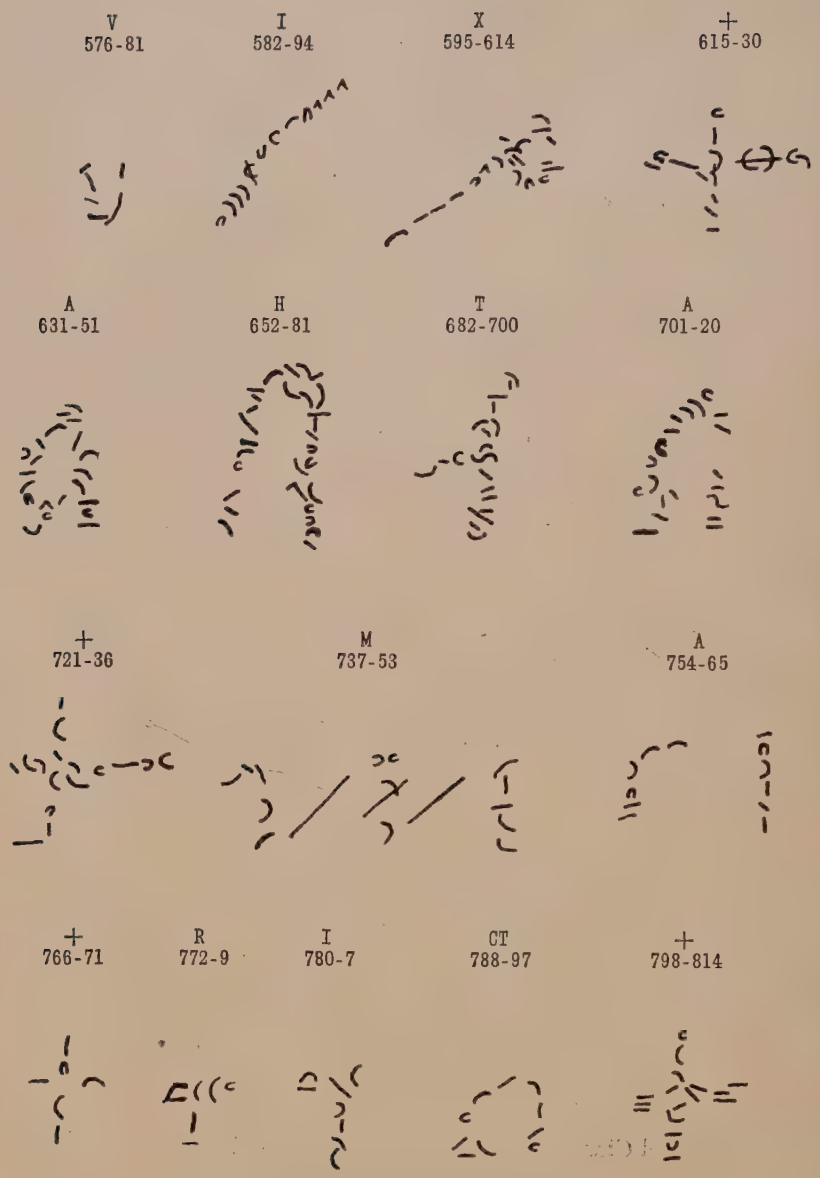


Plate XVIII B

The Shorthand Characters in the Second Line of the Key: second part

[facsimile of Newbold's drawing]

Plate XIX A

The Shorthand Characters in the Third Line of the Key: first part

[facsimile of Newbold's drawing]

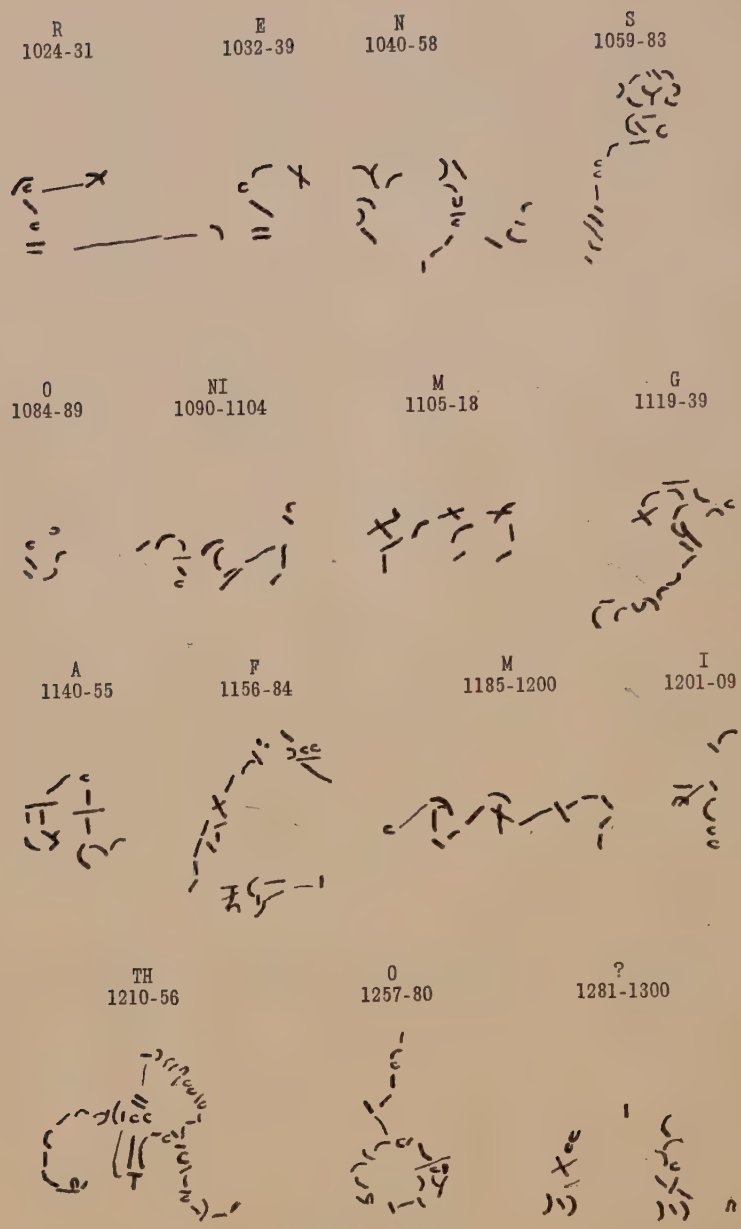


Plate XIX B

The Shorthand Characters in the Third Line of the Key: second part

[facsimile of Newbold's drawing]

720- 760	n ailho	pbohi	pbqts	cduus	tesqp	eseti	tbbee	lstte
760- 800	e lsioi	ihtli	taite	t*h*hqt	tnhsi	phbae	qtepi	eqaut
800- 840	t bettt	ephqu	utttt	oppeb	osote	*p*elte	epeho	bittu
840- 880	u qbnpu	nbtes	suooo	ipqst	eitpe	bubeq	qbbse	llitp
880- 920	p tuaht	ttpba	citue	epeta	ebeob	eioou	eiepp	plooe
920- 960	s tulot	oppbe	uqoet	tsenn	qepui	eepo*b*	*t*ieea	u*c*eee
960-1000	s stbsi	oueap	oiio*u*	oetb*t*	*s*optb	uto*t*o	q*s*oup	t*t*po*t*
1000-1040	*t* *pouus*	eitet	uetts	lieii	eautq	epuqa	apaan	qtiuu
1040-1080	u sphpt	spnrt	qeeiu	botob	*n*uoiq	qt*a*cu	h*t*b*b*t	oupsb
1080-1120	b ebio*u*	qst*e*e	t*i*toq	theee	ie*q*o*e*	oueit	eotet	tieeu
1120-1160	u ttptb	nuedt	putah	*t*btqt	ibeoe	ieeqi	tihp*b*	eeiet
1160-1200	t qethi	det*i*o	ienee	tutnu	soqqq	pioe*p*	*e*t*i*eu	etoei
1200-1240	i tteoh	qqote	labih	ettdh	iithi	qq*b*oo	tstel	eqqeq
1240-1280	q itioq	ttcei	tq*o*sa	elubt	btoei	qtiqe	b*e*qis	be*o*e*o*
1280-1300	o rruee	sosih	tpque	usosl				

[Notes to the transcribed text:

The spacing is intended merely to guide the reader in identifying the numerical value of the letter.

Letters 382–387 were omitted in Newbold's transcription.

Symbols 128, 158, 169, 183, 309, 803 (listed by the numerical value of their second component) are omitted in Newbold's interpretation, no phonetic values being given.

The following readings, in comparison with the facsimile, are doubtful; Newbold's own suggested variants are unmarked here, but those of the editor are in square brackets:]

32	*e:*	[the sign is lacking in the facsimile.]
279	*h:*	[rather *s*.]
313	*c:*	[rather *e*.]
316	*h:*	[rather *s*.]
489	*h:*	[rather *s*.]
521	*r:*	[rather *l*.]
576–81	*asntdi:*	[rather *aouedi* or *euoadi*, by the facsimile.]
609	*h:*	[rather *s*.]
689	*t:*	or *e*.
715	*e:*	[rather *u*.]
777	*h:*	or *i*.
826	*p:*	[rather *t*.]
950–51	*th:*	or *bt*; [rather *pb* or *bp*.]
957	*c:*	or *b*.
975	*u:*	or *p*.
980	*t:*	or *u*.
981	*s:*	?
988	*o:*	or *u*.
992	*s:*	or *l*.
993–1004	*ouptpotpouu:*	[rather *ouptsoouoropt*, adding 1 to the total.]
1061	*n:*	or *u*.

1068	*a:* or *t.*
1072	*t:* or *u.*
1074	*b:* [rather *s.*]
1085	*u:* or *b.*
1089	*d:* or *e.*
1092	*i:* [rather *p.*]
1103	*q:* or *t.*
1105	*e:* or *t.*
1136	*t:* not in facsimile.
1155	*b:* [rather *t.*]
1169	*i:* or *p.*
1192	*t:* or *p.*
1190–93	*peti:* [rather *tepui*, adding 1 to the total.]
1228	*b:* [lacking in the facsimile.]
1253	*o:* or *u.*
1254	*s:* or *b.*
1272	*e:* ?
1278	*o:* or *u.*
1280	*o:* or *u.*

[The recomposed under text is as follows:]

1–40 Scripsi Rog|erus Bacon: S|ententia vu|lt aequari s-
41–80 ingularibu|s literis. Co|njunge alia|m alii promi-
81–120 scue commis|cens ultimi|s primas. Ut c|orresponde-
121–160 ant quaecun|que aliae al|iis, prosunt| sulci usque
161–200 pedes procs|imorum apic|um ducti ecs| finibus cui-
201–240 usque liter|ae, ut nullae| ecscipiant|ur, et comput-
241–280 antur quadr|ingentae oc|toginta qua|tuor. Ecscip-
281–320 iens eas qua|s esse propi|nquas perci|pies, commut-
321–360 es cunctas; p|erspice ne u|llas neglig|as. *H*inc fluun-
361–400 t literae qu|ibus illi ut|untur qui ap|pellantur e-
401–440 cscellenti|ssimi sapie|ntes in volu|minibus cab-
441–480 alisticis s|ecretis mod|is, quorum su|ccessus ali-
481–520 os impulit i|nvestigare.| Postquam ec|spendi appl-
521–560 ications u|niversas, pl|ures inveni| rationes oc-
561–600 cultandi se|creta. Lingu|as perpendi| quascunque
601–640 appre*h*ender|am; in nonnul|lis percepi| voces cum pu-
641–680 uncto in cent|ro accipien|das paralla|cs, congemin-
681–720 atas. Parall|acs omni fac|ta p*h*alange s|ecunda omit-
721–760 tatur liter|a quaecunqu|e nisi final|is sit; illa p-
761–800 ersistat. Ec|spunctis il|lis corruen|t p*h*alanges c-
801–840 ccclcscscs|iv in partem| dimidiam. Ec|scipe quamc-

841–880 unque secun|dam, duplica;| aliis alius| sensus vocu-
881–920 m cuicui ass|ign*a*tur quo|rum quicunq|ue per voces
921–960 "mic*h*i dabas" e|t reliquas s|ignificatu|r. Possis ill-
961–1000 os invenire| per viginti| p*h*alanges qu|ae constitu-
1001–1040 unt copulam | *et* quae illo|s quasi vinc|ien*t*es ad ea-
1041–1080 s, significa|tiones iis a|pponunt. Eff|ingebam alc*h*-
1081–1120 emicas form|ulas sine s|ensu, ut illaq|uearent stu-
1121–1160 pidos ac ign|orantes. *H*ic n|on usus sum *h*a|c fantasia, p-
1161–1200 erpetravi J|ulii Caesar|is volare al|a: Literae "co-
1201–1240 nmuta" in pri|mo loco comm|utant secun|dam illius p*h*-
1241–1280 alangis; inv|icem vero pr|imae voces u|suales Lati-
1281–1288 nae fiunt.

[Notes on this text:

The *h*, inserted in italics for easier understanding of the Latin, is of course not represented in the cipher text.

The spelling *cs* is used for *x*, to agree with the cipher.

894: *a*: either *assignatur* or *assignetur*, since symbol 897–8, used for this letter, may be either A or E.

1010–1036: Newbold's copy has *copulam quae illos quasi vinciens ad eas significationes iis apponunt*, which is either incorrect Latin or unintelligible to the Editor, who has slightly rewritten it.

1192 onward: This is the text of Newbold's first draft, as the revised interpretation ends at 1191. Had he been permitted to complete his work, he would doubtless have made such revisions as the extra symbols—some ten or twelve—demand. —RGK]

[The] uppermost line on [the] Key Page [probably is to be interpreted as follows, although there are some points in it which are not perfectly clear:]

Fiunt *phalanges quae miscentur clavi* ex illis quinque phalangibus

CN NM MI IC CC

Illis annecsui ecstra sumptas ex signis pro "R. Baconi" per "tetara" significatum. Lege omnes cum aspiratione et sine ea in columnam. Ecs decstra lege phalanges in sinistram, tum vero ecs sinistra in decstram, phalanges occupent locos decstros alphabeti in clavi. In pracsei (=πράξει) excipiantur illae voces decem quibus scribas "Iesus Christus, Nomen Suave."

[The italicized words are especially doubtful. In other points this confirms the main part of the Key, apparently meaning about

as follows:] "The symbols which are unclear are the keys of the five groups CN NM MI IC CC." [These have the alphabetic values] O C A B N [= BACON, and are reducible by reversion to the changed values which make the primary uniliteral alphabet into the secondary:]

$$\text{cn} = \begin{cases} \text{cu} = \begin{cases} \text{cr} = \text{cs} = \text{qp} \text{ [or } \textit{pq}\text{, in DAB}\textit{PQ}\text{S]} \\ \text{qr} = \text{es} = \text{ip} \text{ [or } \textit{pi}\text{, in PORT}\textit{QPIS}\text{]} \end{cases} \\ \text{cv} = \text{qt} \text{ [or } \textit{tq}\text{, in PORT}\textit{QPIS}\text{]} \\ \text{qu} = \text{er} = \text{is} \text{ [in PORT}\textit{QPIS}\text{]} \\ \text{qv} = \text{et} \text{ [used at the end of the First Primary Biliteral Alphabet]} \end{cases}$$

nm = vn [or *nv*, in *NV*ULT*CEQS*]

mi = ma = mm = nn = nv [same as the preceding]

ic = ac = mc = nq = ve = ti [used at the end of the Second Primary Biliteral Alphabet]

$$\text{cc} = \begin{cases} \text{cq} = \text{ce} \text{ [in } \textit{NV}\text{ULT}\textit{CEQS}\text{]} \\ \text{qc} = \text{eq} \text{ [in the same]} \end{cases}$$

"To these I joined besides some letters from the groups meaning *R Baconi*, in the meaning *tetara*," [or *four:* that is, *te tccr terc* or *te tar cerc*, in the meaning *four*, is to be taken as *quatuor* and added to the Primary Biliteral Alphabets].

"Arrange all in a column, with and without the aspiration." [This gives the difference between *MICHI* and *MICI*, in the First and the Second Biliteral Alphabets. The arrangement in a column is seen in Table II of Chapter XX.]

"From the right side put the symbols on the left, then from the left put them over to the right; let the symbols occupy the places on the right of the alphabet in the Key." [This seems to direct that the Third and Fourth Biliteral Alphabets be formed by reversing them, as was explained in Chapter VI, but that in writing them in columns the value is always at the left and not at the right.]

"In practice let those ten symbols be avoided with which you may write *Iesus Christus*, *Nomen Suave*."[18] The ten are probably *ro* = I, *sa* = E, *lu* = S, *at* = U, *ta* = C, *me* = R, *er* = T, *as* = N, *ti* = M, *tu* = A.

[With these additions to the main text, a pretty complete account of the cipher has been presented in the Key Page.]

[18] [Presumably to allow the writing of these sacred words in a way which could be used for no other meaning.—RGK]

CHAPTER X

The Annular Eclipse of 1290

[There is a drawing in the Voynich Manuscript, folio 67 r, which it was my wont to term the "Mystery Picture," because of the puzzling nature of the representation.[1] It proved to be a] diagram of an annular eclipse. The center shows the eclipsed sun with influence streaming out along axes; the lower right corner shows four planets with their combined influence streaming inward toward the sun along the diagonal.

> Istam eclipsin observavi Ocsoniae nonis Septembribus
> anno Domini millesimo ducentesimo noningentesimo.
> Acsis macsima orbis lunae illic procsima acsi solis erat.

This caption, unless I am greatly mistaken, records Bacon's observations of the annular eclipse of September 5, O.S. (August 26, N.S.), 1290. I have hopes that when it is all deciphered it will afford conclusive proof that the cipher is being read, for it ought to be possible to verify the statements made. Some can be verified as it is; e.g., the central legend was the first I read, and I made it out as

Anularis eclipsis hinc amputat virtutes quae illic ab sole iactantur.

At that time I had no idea what the diagram represented, except that it was something astronomical, and when I deciphered this legend I thought it was a theoretical reconstruction from an astrological point of view, of the effects of an annular eclipse. A week or more later I made out another [legend] as follows:

> Hic stella basilica, nunc procsima soli,
> praeceps obscuratur lumine solis.

[1] [Nearly all of this Chapter is taken from a letter written in February, 1920. The legends are those above the upper left quarter of the sun and below the lower left quarter.—RGK]

The mention of Regulus, the *stella basilica*, first suggested to me that he was dealing with an actual eclipse, and I called up the observatory and asked whether he could have seen an annular eclipse. Professor Eric Doolittle told me that he was dealing with an actual eclipse and has promised to calculate the exact position of Regulus at the time.[2] He told me he thought Regulus was then distant about 12° from the sun, and that, if the eclipse were nearly total, Regulus would probably be visible for a very short time and then abruptly disappear. This looks promising, but it falls short of the absolute demonstration which I wish to have before making any definite claim. The caption I did not read until after I knew of the eclipse of 1290, which of course weakens the strength of its evidence.

[The three Latin legends have the following meaning:
(1) "That eclipse I observed at Oxford, on September fifth, 1290. The greatest axis of the moon was on that occasion very near the axis of the sun."
(2) "The annular eclipse cuts off from here the virtues which are cast off there by the sun."
(3) "On this occasion Regulus, now very close to the sun, is suddenly obscured by the sun's light."]

[2] [This was written in February, 1920. Professor Eric Doolittle died on September 21 of the same year, and there is no record that he made the promised calculation. —RGK]

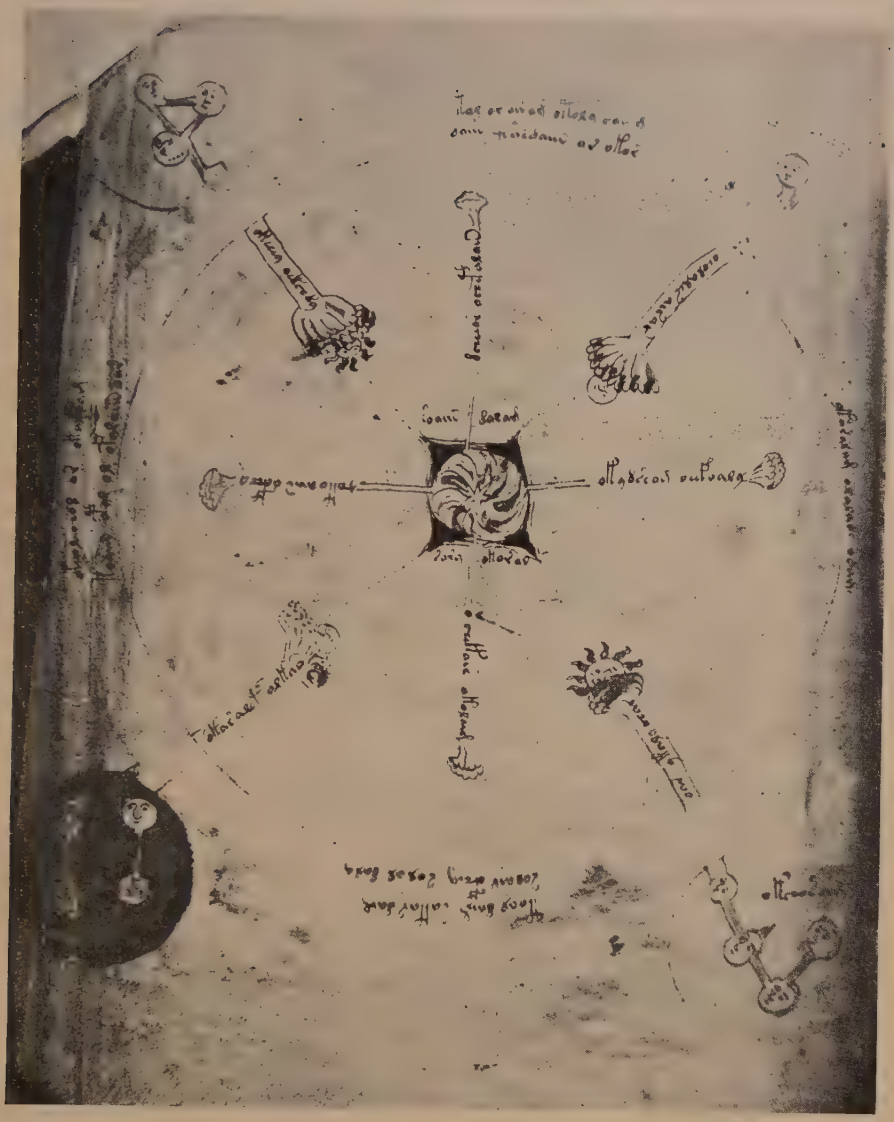


Plate XX

The Annular Eclipse of 1290: folio 67 recto

Courtesy of Wilfrid M. Voynich

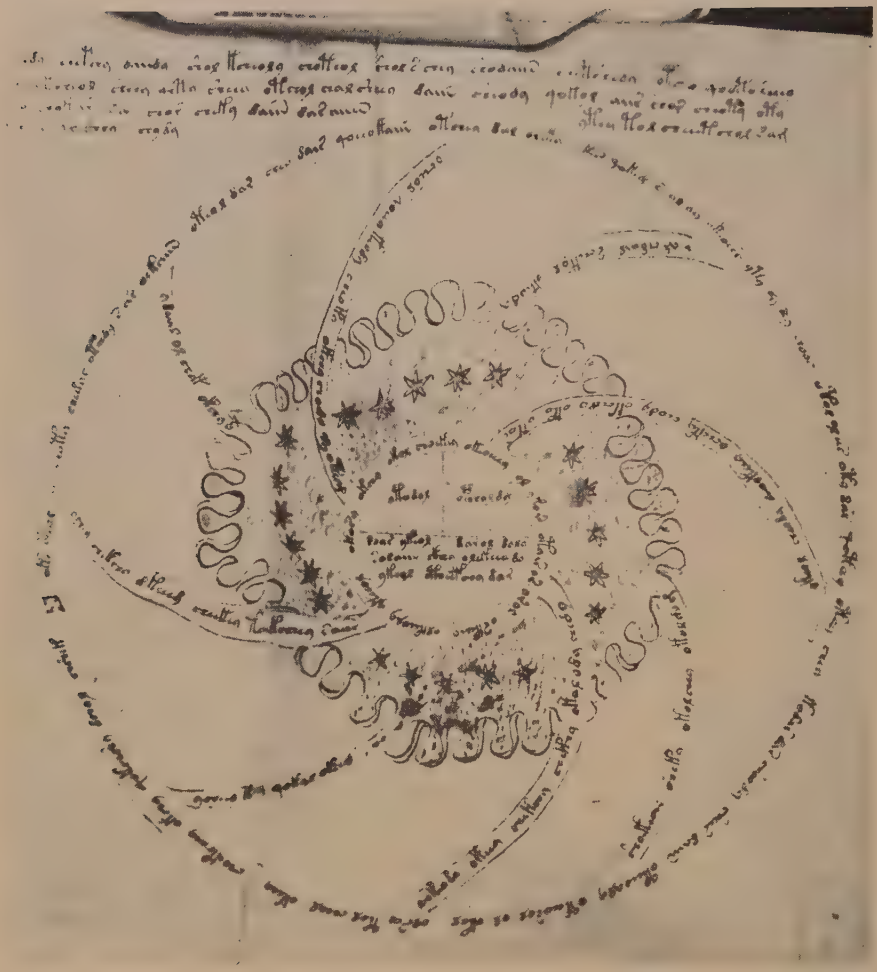


Plate XXI

The Spiral Nebula: folio 68 recto

Courtesy of Wilfrid M. Voynich

CHAPTER XI

The Great Nebula of Andromeda

[The Plate which accompanies this Chapter gives one of the pictures in the Voynich Manuscript, folio 68r, which attracted my attention very early.[1]] From a central circular space, within which is a legend, curved arms reach out toward a circular boundary, passing through masses of blue flocculi interspersed with yellow stars; here and there are irregular, greenish blotches. The late Professor Eric Doolittle,[2] of our Flower Observatory, told me that in his opinion it unquestionably represented a nebula, and that the man who drew it must have had a telescope. The legend is extremely difficult to decipher, but my first attempt gave the location of the object as between "the navel of Pegasus, the girdle of Andromeda, and the head of Cassiopea," and stated that it was seen in a concave mirror. The Great Nebula of Andromeda lies within the triangle determined by these three points; it is therefore presumably the object which Bacon saw. Furthermore, since I did not know at the time that any nebula would be found within the region thus defined, it is probable that those words at least were correctly deciphered. Bacon's attempt to portray the spiral structure of the nebula is also of considerable interest. This spiral structure can at present be detected by photographs only; it is not visible even in the most powerful telescopes. The nebula must therefore have changed considerably in appearance in six hundred and fifty years.[3]

[1] [The greater part of this Chapter comes from the printed text of the lecture before the College of Physicians of Philadelphia, pages 464–465.—RGK]

[2] [Late Professor of Astronomy in the University of Pennsylvania.]

[3] A. S. Eddington, in *Encycl. Brit.*, 11th ed., xix, 332d; art. *Nebula*: " ... The elliptical nebula in Andromeda. Modern photographs show very clearly that its structure is spiral. The nucleus is large and appears circular, but the spirals proceeding from it lie in a plane inclined at a rather sharp angle to the line of sight, and this gives the nebula its elliptical appearance."

Charles A. Young, *Manual of Astronomy* (1909, p. 555:) "It cannot, perhaps, be stated with certainty that sensible changes have occurred in any of the nebulae since

[The deciphered text, whatever its value or lack of value,[4] is as follows:]

1– 41	Vidi stellas in speculo concavo, in coc*h*leae forma
42– 89	agglomeratas, luminantes lumine visibili inter stellas
90–137	quae porrectae sunt inter umbilicum Pegasi, cincturam
138–178	Andromedae, et caput Cassiopeae. Pegasus illis prae-
179–224	currit procsimus, effigies equi alati cuius alae penna
225–270	tangit coluro qui secat hemisp*h*eram septentrionalem
271–313	versus aequinoctialem punctum. Spira involuta est
314–357	stellarum quae lucent suo lumine in nebulis spissis
358–391	stellarum quae iacent in spiris coc*h*leae.

they first began to be observed—the early instruments were so inferior to the modern ones that the earlier drawings cannot be trusted very far; still, some of the differences between them and more recent representations and photographs make it extremely probable that real changes are going on. At present the best authenticated instance of such a change, according to Professor Holden, is in the so-called 'trifid' nebula in Sagittarius. In this object there is a peculiar three-armed area of darkness which divides the nebula into three lobes. A bright triple star, which in the early part of the century was described and figured by Herschell and other observers as in the *middle* of one of these dark lanes, is now certainly in the edge of the nebula itself. The star does not seem to have moved with reference to the neighboring stars, and it seems, therefore, that the nebula itself must have drifted and changed its form."

Just as my lecture was about to go to press, Professor Schlesinger, of the Yale Observatory, sent me the following objection, which I obtained his permission to print: "The supposed change in the nebula would necessitate movements of its parts in or across the line of sight, or both. If, then, it is distant 300 light-years (and this is the very minimum allowable) it can readily be shown that the outer parts of the nebula must be travelling in the line of sight at a rate of nearly 1000 kilometers per second as compared with the axis of the nebula. If the distance is 100 times greater (and this is more likely), then these relative velocities will be of the order of the speed of light. The supposed motions of portions of the nebula, as compared with others, across the line of sight would amount in some portions to nearly ten seconds of arc in a year. If such a change as this existed it could easily be detected without measurement, by merely comparing two photographs taken twenty or thirty years apart." As Professor Schlesinger's objection involves issues which I am not competent to discuss, I can do no more than put it on record for the consideration of astronomers.

[4] [And however its value may be affected by the argument of Professor Schlesinger. The Editor presents the text because of its interest, although it was an early effort of Newbold which he might not have wished to publish in this form.—RGK]

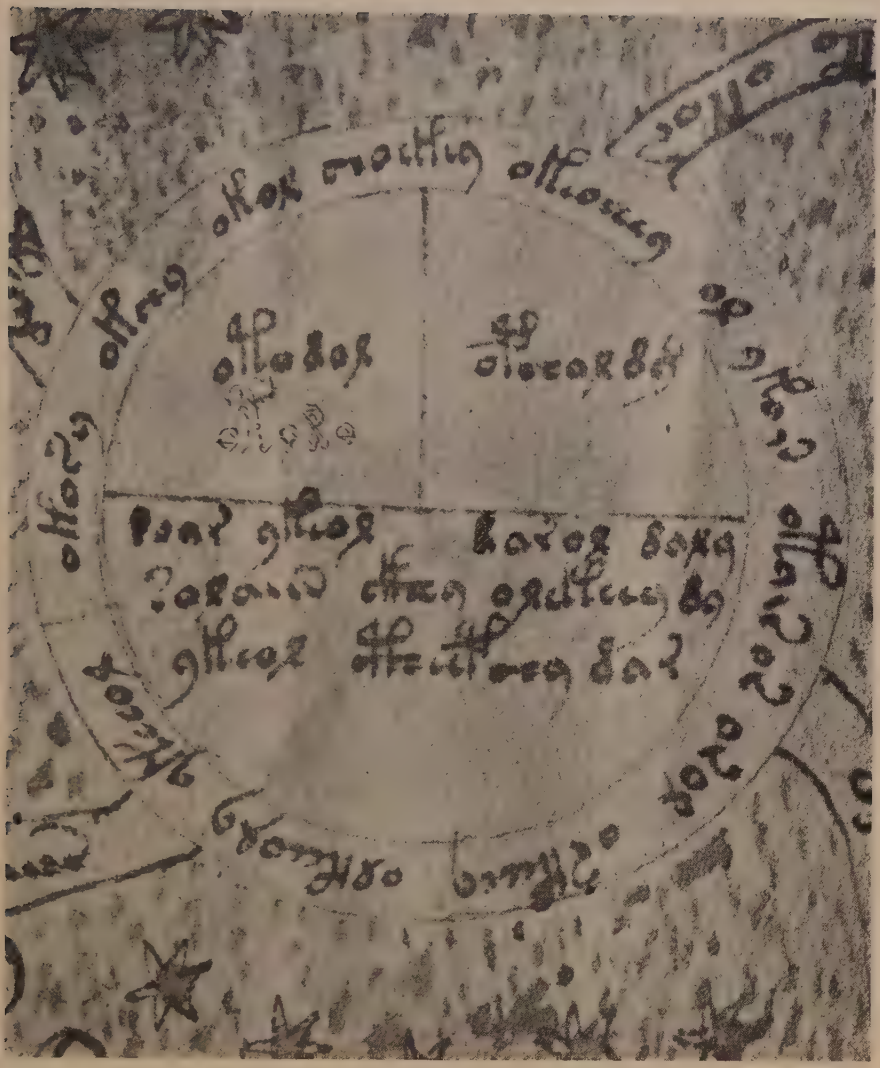


Plate XXII

Center of the Nebula Drawing, enlarged

[the upper left quadrant shows Newbold's drawing of the cipher characters]

Courtesy of Wilfrid M. Voynich

CHAPTER XII

The Comet of 1273

In December, 1920, I deciphered the opening words of the legend[1] on page 71 verso [of the Voynich Manuscript], a drawing of the sign Taurus, as follows:

"The highest Being transcends extinction. If material principles be aggregated into comets, the spiritual (principles or beings) flee away. . . . *not deciphered* . . . 1273 a star with thick hair soars on high. The air grows heavy. The spirit of the blackbird is oppressed. They gather together out of the open under roofs. Margaret, an exile, knowing where she had dwelt among the stars, eagerly asks to join the company in the marble palace of God."

Here are three facts which obviously call for verification:

(1) The appearance of the comet in 1273.
(2) The doctrine that the specific effect of a comet is to loosen spirit from matter.
(3) The fact that this comet loosened "Margaret's" spirit from matter.
As a fourth, we may reckon the effect of the comet on the atmosphere.

I found in *Annales Monastici*, vol. iv, page 467 (Rolls Series), an entry for 1274 (not 1273), "On the vigil of St. Nicholas (i.e., December 5) an earthquake, lightning and thunder, a fiery serpent and a comet terrified the English." Then follows a note of the coronation of Edward I, xiv. Kal. Sept. [= August 19], at which were present the King of Scotland and John, Count of Brittany, with their wives, the King's sisters, who shortly afterwards died. From other sources I learned that their names were Margaret and Beatrice and that they died in Lent, 1275.

[1] [The first part of this chapter is taken from the letter to Provost Penniman, written December 14, 1923. The transliterated text and the complete recomposed text are from other papers.]

As soon as I *knew* the date December 5, I had no difficulty in reading the undeciphered letters as *Nonis Decembribus*, i.e., December fifth. But I could not make the year agree with the Chronicle; [in the cipher] it was 1273, not 1274. I then looked it up in Chambers' *Descriptive Astronomy* (Oxford, 1867), p. 402, and found: "1273. On Dec. 5th a new star appeared in the Hyades. It moved through Auriga past θ, φ, υ Ursae Majoris, ϵ, σ, ρ Boötis to Arcturus, and remained visible three weeks.—(Gaubil)."

Gaubil was a Jesuit missionary who in the eighteenth century made abstracts of the Chinese astronomical records. Thus my reading of the year agrees with the Chinese records. Further, this legend is written in *Taurus*, and the comet appeared in the Hyades, which are in the "face and horns" of Taurus.

The name Margaret cannot be taken as evidence, because I read it in the Chronicle before I deciphered it in the text.

The strange theory of the effects wrought by comets gave me much trouble. That comets are portents of evil is of course an accepted fact in astrology, but in all my rather extensive reading of the subject I had never seen a reference to this specific effect, that of loosening the bond between spirit and matter. It is not, for example, mentioned in Bouché-LeClerq's section on comets, in *L'Astrologie Grecque*, pp. 357–362 (Paris, 1899). I searched through Bacon's works in vain. Then I procured from the British Museum a photograph of an unpublished note of Bacon's on comets,[2] but it also contained no reference to the doctrine in question. I then gave up the search. About a year later I was reading the works of Robert Grosseteste, Bacon's teacher, and in his tract "On Comets" I found the doctrine in question. But the text printed by Baur in 1912 is extremely corrupt and in part unintelligible.

This summer[3] I found in Florence a tract on comets, listed by Professor Little among the undisputed works of Roger Bacon, which is the original, complete document, of which Baur's text is a corrupt and mutilated version. It explains in full the reasons why comets exert this specific effect upon inanimate as well as [upon] animate nature. I cannot now go into the theory at length, but one sentence will suffice to show its identity with that which I read in the [Voynich] Manuscript:

[2] Now in Royal MSS 7 F. viii f. 11.

[3] [The summer of 1923.]

Plate XXIV

The Sign Taurus: folio 79 verso

The words inside the inner circle tell of the Comet of 1273; the legend begins with the word under the Bull's forefoot, and those in the detail drawing are just above the manger

Courtesy of Wilfrid M. Voynich

"From this therefore it is manifest that a comet, which is fire sublimated from the parts of the world of sense, is a sign preceding, of the sublimation and separation of the spiritual nature incorporated in complex things and assimilated to the star attracting the comet in its specific nature. It is therefore a sign of the weakening or corruption of the complex things over which the planet rules to whose nature the comet seen is assimilated."

There is no doubt in my mind that Little's attribution of this tract to Bacon is mistaken; it is the work of Grosseteste. But that Bacon accepted the theory is obviously implied in one of his two references to it (*Opus Maius*, I 108): "Famous men have been found, for example Bishop Robert of Lincoln and Brother Adam Marsh and many others, who by the power of mathematics have known how to explain the causes of all things and to set forth satisfactorily things divine and human. The assurance of this fact is self-evident in the writings of these men, as for example *On Impressions*, *On the Rainbow*, and *On Comets* and *On the Generation of Heat*, . . . and others." Grosseteste has left works with these titles, but of Adam's works nothing is known.

All the ideas of this passage are therefore completely verified.

[The following is the text to which the preceding narrative refers. The original is in the central circle of the drawing of the sign Taurus, and consists of the following shorthand signs, arranged by apparent "words" and letters:]

(1) eeocpse hhbiedithihu utenpu iuundestt
(2) t hiepe huburesttib ahttct acue bpueitt
(3) t hepqnus bpu nueep
(4) p buqpti qqbecpteittheio uhe uiet ottui
(5) i iblhettesptdiob bm eioreluob
(6) b abes ihueniedthsir aie bt ahpti
(7) i utpee iitieestie acues aheeqpt heu nedul
(8) *l* aoes hqqietuteppehihp bep ipu neipt
(9) t bltlob hitbteetuthiut bt aotaout cub ouhsseoo
(10) o utse uhqsebuedpttiqa beb unrpoot
(11) *t* oecqtequ auc oc oiehtethqsea cepua butit beeut
(12) t rberue qqhceqieebteteqptheiba obteosnu uqueep
(13) p ehtttst ecet aohtqq suheeioq

(14) q roucreuqothtueb aqhuse nheoseq erhputrbuttucet ebteshulibpee

(15) e arppi oeostli*mt* abpa nottuoohetilstoeplt*u*ippurqiee ubtoph bludpm

(16) m qtlpeth ecqphpll*oeo* lqirt bqtpqieuo ritiqerudote*o* eqtourqb lstuoeeuetdruqer qcopuueqqq

[The following characters are somewhat uncertain:]
Word 6: *t* or *p*
Word 7: *l* or *r* or *o*
Word 10: *t* is doubtful
Word 11: *o* or *u*
Word 15: *m* or *ti*; *u* or *e*
Word 16: *oeo* or *eoo*; *o* or *q*

[The recomposition of this text is as follows:]

1– 56 transcendit summum esse ecsstinctionem. si principia materialia

57–112 aggregantur in cometas, spiritualia aufugiunt. nonis decembribus

113–174 millesimo ducentesimo septuagesimo tertio, stella cum crinibus

175–228 spissis AIOREITAI.[4] aer torpet, stupet spiritus,[5] meruli coeunt ipsi

229–293 ecs coelis sub tecta. Margareta ecsul cognoscens quo incolarit in

294–335 stellis, ancsia poscit congregari in marmoreas domus Dei. Currit

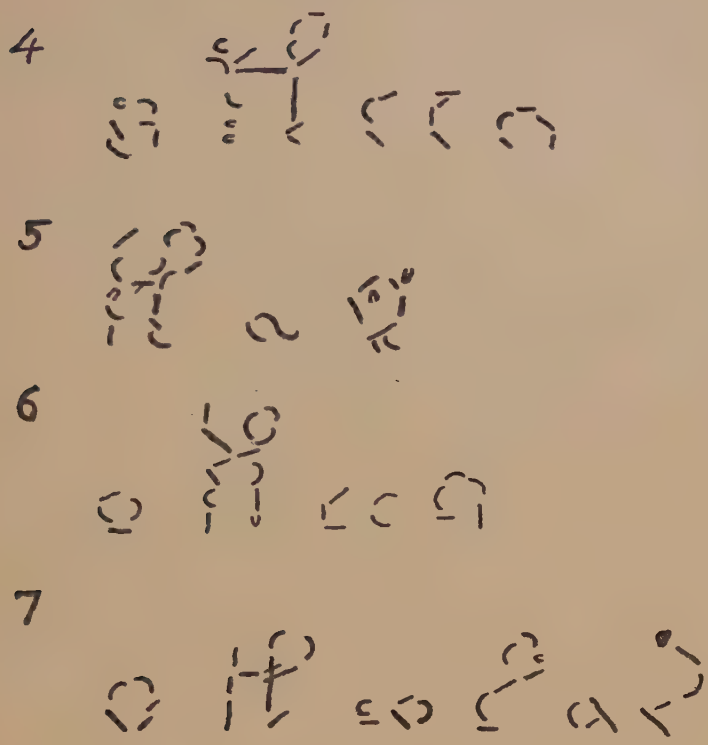
336–389 Aprilis suavissime, occurrit lues intestinalis, moriuntur circa

390–411 CCC. ecspirant plorantes . . .

[The following is the detail of a part of this text. The values of two symbols remain over from the preceding; the fresh values begin with *itth* in "word" four, that of *th* going back into *cometas*; the

[4] A Greek word, αἰωρεῖται.

[5] [Unless the "spirit of the blackbird" has some technical meaning, the Editor would rather translate: "The air grows heavy, the spirit is oppressed. Blackbirds gather together out of the open under roofs," departing from Newbold's version. —RGK]



The Comet Legend
Detail of "Words" Four to Seven

last values used are those of *acu* in "word" seven, with a remainder of three symbols:]

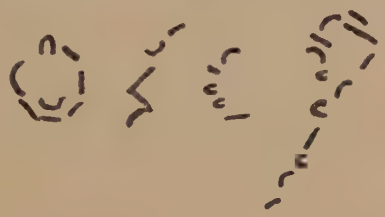
```
mp S : i  c  u  I  N  O  N                  1-5   N O N I S
   5           4  3  2  1

Mp i  c  U : mr  D  E  I  R  Pc P  c  C  E  S
10      15      6  7  13 12 11 14    8  9  16
                                          6-16  D E C E M B R I B U S

I  c  Mr c : Mr I  Ra mr R  c  pt  i  pc  n  t  r  E  S  e  mrt O
23    24     17 18 19    20                       21 22        25
                                         17-25  M I L L E S I M O
```

```
C  c  Mr c Tp i  p  cp  N  T  r  E  mrt : r  U  Er I  U  S
28    35   26          30 31    29          27 32 34 36 33
                                            26-36  D U C E N T E S I M O

C  c  i  P  cp r  Tmr r : E  Umr Mr S  I  r  t  E  A
43      39      40     44 41  47 37 46      38 42
                                            37-48  S E P T U A G E S I M O

c  I  cp r  R  T : t  rms i  T  E          49-54  T E R T I O
   53      51 52           49 50

C  cp R  R  T  Smr i : E  U  r  Mc         55-63  S T E L L A  C U M
61    58 59 56 55     57 62    63

Pc I  R : e  S  I  S  Cm N  mtr i  U  Ar   64-71  C R I N I B U S
69 66 65    71 68 45 64 67       70 60

e rmt i : Ic S  O  Pea S  U  S  ir a  I  S
          74 72 48 73  75 54 76      77 78
                                            72-78  S P I S S I S

E  Tmr I  ri A : I  ispn A  I  O  i  R    79-87  A I O R E I T A I
83 85  84    86  87     79 80 81    82           = αἰωρεῖται
```

CHAPTER XIII

Cato and Fulvius

[In the series of drawings in the Voynich Manuscript,[1] representing the signs of the zodiac, is one representing the sign] Libra; [this is folio] 72 verso. Up to the right [is a figure] grasping a star; [it is the] face with a spot. [There is] a legend attached to [it, which may be interpreted as follows:]



```
 a u u h l o i e   t u e d e   a q q o t   q p u t u n e t c e q t e
   C S N E O P I   R C A T O   U I U L P   P L C S C N E L C O I N T
   M   I   M                             A   E             A   U   P
                                             A

Cm S  N  Ei O  pm i  R                   8     1- 6  C E N S O R
pm i : C  A  T  O                       12     7-10  C A T O
Mp i : U  I  U  L  Pa                   17    11-17  F U L V I U M
i : epa l  c  s  c  N  e  l  Ca U  Ui N. 30    18-21  N U N C      .
I Epa L C S C E L Tp :                  30    22-30  E C S C E L L I T
```

"Cato the Censor now surpasses Fulvius."

Apparently an allusion to the rivalry between Cato and Fulvius Nobilior. Fulvius was defeated [184 B. C.] in the contest for the censorship, Cato being elected; but in the following year[2] Fulvius was elected. Cato later wrote a speech attacking him for his administration of the censorship, and for granting crowns to his soldiers on trivial grounds. Fest. *Frag.* 282 Müller; Cic. *de Orat.* 2.256; Livy 39.40; Cic. *Tusc.* 1.2; Aul. Gell. 5.6.24.

[1] [This Chapter is taken from miscellaneous papers.—RGK]

[2] [Censors were elected only every fifth year. Newbold means at the next election. —RGK]

The first three words are quite clear, but the last two uncertain. Trivial errors would change *nunc* into *non* and *excellit*[3] into *expellit*. Lack of context makes it impossible to judge which is the more probable.

[When I read this legend,] I knew no association between Cato and Fulvius; but on looking up *Fulvius* in Pauly-Wissowa, [*Real-Encyclopädie der classischen Altertumswissenschaft*, VII 266–267,] I found the data already presented. The connection is therefore confirmed.

[3] [*Excellit* is in classical Latin intransitive, governing a dative in this meaning; but by Bacon's time it may have got the use given in this sentence.—RGK]

Plate XXV

The Sign Libra; folio 72 verso

The Cato-Fulvius legend belongs to the figure above and to the right of the center

Courtesy of Wilfrid M. Voynich

CHAPTER XIV

The Oxford Story

[In my account of the characters of Bacon's cipher, I had occasion to comment upon the absurdity of the literal meaning of certain alchemical texts written by Bacon. As I said there, it is ridiculous to think that a man of Bacon's gifts could have written such nonsense and have intended it as a serious document, according to its surface meaning; he must have been writing in cipher and have been trying to conceal the fact that the document had any other meaning than that of its obvious Latin text. One of the passages there quoted in translation, to show its absurdity, is the first part of Chapter X of the *De Secretis Operibus Artis et Naturae, et de Nullitate Magiae.*[1]

My attention was first drawn to this Chapter by the fact that it makes such arrant nonsense. But when I applied to it the principles of the cipher, I immediately began to get results, and I saw that it was in reality a cipher document. First there came a date in the year 1273, with a statement that at this time Edward I had ordered an investigation into crimes that had been committed, and the arrest of those who had committed them. So far I read, 133 letters of the recomposed text, including the word *arrestarent*, and then made a note on a worksheet which is still preserved,] "Finished April 2, 1920, 11.20 A.M. I don't know whether it is true or not." [Then I went on further with the interpretation and got an account of

[1] [Printed in Brewer, *Op. Ined.* 548–550. But this is not the only text of the sort printed by Brewer; Chapters IX and XI also are in cipher. The three chapters are] given by Brewer on pages 545–551. Chapter IX has been displaced; the order is X, XI, IX. The conclusion [of the narrative contained in them] is preserved in a different recension [printed by Brewer on] pages 313–315. To effect connection between the two, the words *et cum vapore*, p. 547, to *dessicantibus*, p. 548, should be taken as identical in meaning with the similar words, p. 313, [with which the mutilated manuscript of the *Opus Minus* begins. Of these various sections, it is of Chapter X only that the deciphered text was in sufficiently finished form to be presented in this volume. The present Chapter is drawn from sundry notebooks and papers.—RGK]

riots at Oxford between the *milites* or knights and the ecclesiastics. The narrative may be thus paraphrased in English:[2]]

"On March 4, 1273, King Edward directed all the ecclesiastics of his kingdom to seize the vicious and to arrest the wrongdoers and criminal, that the dishonest might be put to confusion. They were accordingly arrested, that the King might be satisfied. But they were straightway freed from custody, because the ecclesiastics feared the neighboring knights; for any one at all might know that the end of their power was come if the monks could arrest them, and could attract from their serfdom the serfs, by the joyous carols and solemn hymns of the Church, that they might free them from the savagery of the King and the power of the knights.

"Now at Oxford there were knights studying; they take arms against the ecclesiastics. The knights at Oxford bring military supplies secretly. Then the monks take a similar step against their foe: they charged the knights with schism, declaring that they had procured arms because they felt that they were guilty. The knights, fearing the monks, made fine excuses to the King: they (the monks) would demand the arrest of those whom they charged with the crime, that they might build up a pretense of their hostility; they have been challenged by them, to frighten those;[3] that pretense will turn into a trap. At that the ecclesiastics shut their gates and blocked up the lower parts of the rear entrances, which they turned over to Roger Bacon of Ilchester to guard, who was likewise also an exile[4] from among the Celts, from Knockane in Munster, a city of Ireland.

"The knights in vain came out to the ford of the Thames where the House of the Friars Minor stood, on a level with the river.[5] But the shouts of the populace implored them to keep away from the bank. When the populace was through, the knights (not

[2] [The paraphrase is the work of the Editor. To Newbold, every word of the text had its precise and appropriate significance; and while Newbold probably remarked to the Editor on the meaning of each item, in the many conversations over this text, there are all too many phrases which no longer recall to the Editor the ideas which they conveyed to Newbold. Errors and inadequacies in the translation must therefore not be charged to Newbold, but to the Editor.—RGK]

[3] [Those charged with the crime?—RGK]

[4] [See note 17.—RGK]

[5] [If this be the meaning.—RGK]

wishing to go against popular opinion) gave the military salute just as they gave it to the Chancellor when he was presiding in a military capacity.

"This draws the clerics to an uprising, even if the Chancellor was satisfied that the same show of respect be given to the outstanding Hundred-and-Sixty who ...[6] and to the presiding officer of the whole body of scholars. But saints do not like bloodshed. Bacon has himself sent into the city to buy willow charcoal mixed with a solution of saltpeter and with wine,[7] on the pretence of buying medicine. ... On April second, the knights had gone off, that in this way—whether it be avoidance or non-performance—the excuse for their wrongdoing might be the old custom of taking beer and wine straight on April first. When things turn out successful, there will be no investigation into things gone by; even the greatest crimes, in case of success, men are wont to say nothing about."

[There are points in this narrative which should be susceptible of verification, if events did actually take place as I read them in this text. I devoted much time to a study of the period, and while neither the King's inquisition into crimes nor the riot at Oxford is mentioned in the histories, the original documents give distinct indications of these occurrences.

Henry II of England died November 16, 1272. His oldest son Edward, who succeeded him on the throne, was at that time coming back from the Holy Land, whither he had gone as a Crusader in 1268. Things in England were peaceful, and he delayed his return until August, 1274.[8] But he was received by the Pope at Rome on St. Valentine's Day, 1273,[9] and at no late date in the year two papal nuncios came to England, apparently speaking on behalf of King Edward also, demanding payment of large sums of

[6] [The words here and in the similar place later on, are obvious, but they do not suggest to the Editor the meaning which Newbold had for them.—RGK]

[7] [Ingredients for gunpowder, with which to make fireworks and thereby frighten off the besiegers.]

[8] The oath of allegiance to Edward was taken by the assembled dignitaries and representatives at Westminster a little *post festum Sancti Hyllarii* (January 13); *Annales Monastici*, II 379 (Rolls Series), anno 1273. Edward's return to England is recorded in the *Patent Rolls*, p. 55.

[9] *Annales Monastici*, I 264 (Rolls Series, ed. H. Knighton).

money to Edward for his expenses while away, and instituting an investigation into crimes and misdoings.[10]

It is quite possible that this is the investigation which the cipher document speaks of as ordered by the King; the date also is not far from that mentioned in it. When we come to the riots, we have no trouble in ascertaining that there were riots at Oxford in 1273; but they are spoken of as taking place between the *Boreales* or Northerners and the *Hybernenses* or Irish; both parties are spoken of as students, and the fighting was severe enough to result in numerous deaths.[11] The King's representatives at London, acting in his name, demanded the arrest of the guilty parties,[12] and the Mayor and Bailiffs of Oxford succeeded in having numerous arrests made.[13] In the early part of 1274, there were some forty-five persons whose names are recorded in extant documents, awaiting trial at London or at Oxford, charged with homicides and other trespasses during the disorders at Oxford.[14]

That there were disorders at Oxford at about the time set by the cipher text, seems clear. It is not clear that the ones mentioned in the records are the same disturbances as those in the cipher text; but at any rate conditions at Oxford were such that an outbreak between the knights and the monks cannot be regarded as unlikely. With this comment from the historical standpoint I must leave the document to stand on its own merits.

The following is the Latin text of Chapter X, in the version which I have used for the decipherment. The numbering counts symbols, not letters: a word of five letters contains four symbols:]

[10] *Ann. Mon.* II 379: *Eodem anno et eodem tempore* (= soon after the administering of the oath of allegiance, note 8, above) *venerunt duo nuntii domini Papae Londiniam, qui supplicationem ipsius clero regni destinatam, scilicet ut decimam omnium bonorum ecclesiasticorum pro biennium domino Edwardo et eius germano pro eorum dampnis et expensis in terra sancta concederent, ostenderunt, super hoc deferentes et ostendentes quosdam articulos apostolicae potestatis super quibus inquirerent, prout inferius continentur, videlicet:*

De infringentibus jura ecclesiastica et libertates; and 49 other items.

[11] *Ann. Mon.* I 267 (Rolls Series, ed. H. Knighton), anno 1273. *Eodem anno discordia extitit magna Oxoniae inter clericos aquilonares et hybernicos, et aliqui occidebantur.*

[12] *Mediaeval Archives of the University of Oxford*, ed. H. E. Salter (1920), App. I 331.

[13] Ib. 332.

[14] Ib. 30–33. Cf. also *Calendar of Close Rolls*, 1272–9, pp. 66–67; *Calendar of Patent Rolls*, 1272–81, pp. 44, 48, 62, 65.

1–40 De eodem, sed alio modo. Transactis annis Arabum secscentis
41–79 et duobus, rogasti me de quibusdam secretis. Accipe igitur
80–118 lapidem, et calcina ipsum assatione *levi*, et contritione
119–157 forti sive cum rebus acutis. Sed in fine parum commisce de aqua
158–200 dulci; et medicinam lacsativam compone de septem rebus si vis, vel
201–238 de secs, vel de quinque, vel de quot vis; sed quiescit animus meus
239–281 in duabus rebus, quarum proportio *quare mollior erit in secs quam*
282–320 altera proportione, vel circiter, sicut te potest docere
321–363 ecsperientia. Resolve tamen aurum ad ignem et mollius calefac;
364–397 sed si mihi credas, accipias rem unam, hoc est secretum
398–443 secretorum et naturae potens miraculum. Micsto igitur ecs duobus
444–481 aut ecs pluribus, aut phoenice, quod est animal singulare,
482–520 *ad ignem* et incorpora per fortem motum; cui si liquor calidus
521–565 quater vel quinquies adhibeatur, habebis propositum ultimum.
566–607 Sed postea coelestis natura debilitatur, si aquam infundis
608–642 calidam ter vel quater. Divide igitur debile a[f] forti,
643–682 in vasis diversis, si mihi credas: evacuato igitur quod bonum
683–725 est. Iterum adhibe pulverem, et aquam quae remansit diligenter
726–760 ecsprime: nam pro certo partes pulveris deducet non
761–800 incorporatas; et ideo illam aquam per se collige, quia pulvis
801–842 ecssiccatus ab ea habet *enim medicinae in corpore lacsativo.*
843–880 Fac igitur ut prius, donec forte a[d] debili distinguas, et ter,

881–922 vel quater, vel quinquies, vel plus, pulverem adhibeas: et semper
923–961 uno modo facias. Quare si cum aqua calida operari non poteris,
962–1000 fac aquam *alcali*, et per huiusmodi acuta medicinae facies
1001–1038 violentiam. Si autem propter *acuitatem* aut mollitiem
1039–1080 medicinae frangatur, pulvere apposito, appone caute plus de
1081–1120 duro et molli. Si vero propter abundantiam pulveris, appone
1121–1161 plus de medicina. Si vero propter fortitudinem aquae, regyra
1162–1200 cum pistillo; et congrega materiam, ut potes: et aquam separa
1201–1239 paulatim, et redibit ad statum; quam aquam ecssiccabis; nam
1240–1283 continet pulverem et aquam medicinae, quae sunt incorporanda
1284–1323 sicut pulvis principalis. Non dormias hic, quia valde utile
1324–1362 et magnum *continentur* secretum. Si vero partes virgulti
1363–1403 coryli et *salices*, multarum iusta *rerum apte* ordinaveris,
1404–1443 unionem naturalem servabunt, et hoc non tradas oblivioni,
1444–1485 quia valet ad multa. Citrinitatem vero cum unione liquefacta
1486–1522 miscebis; et ecssurget ut credo simile lapidi *H*ibero, et
1523–1566 proculdubio mortificato quod mortificatum est per vaporem
1567–1603 plumbi. Invenies plumbum, si ecsprimas vivum a*b* mortuo;
1604–1639 et mortuum sepelies in *clibano* et sarcocolla. Tene hoc
1640–1679 secretum, nam nonnullius est utilitatis. Et idem facias cum

1680–1718 vapore margaritae vel lapidis Tagi; et sepelias mortuum
1719–1726 tuum, ut dicsi.[15]

[The deciphered and recomposed text is as follows:]

1–42 Quarto Martii anno Domini millesimo ducentesimo
43–85 septuagesimo tertio ille praecepit recs Eduardus
86–122 ecclesiasticis omnibus regni sui ut impios
123–165 arrestarent[16] et attac*h*iarent iniquos et sceleratos
166–203 ut essent improbi stupefacti. Illi attac*h*iati
204–240 sunt, ut approbaret recs. Sed emancipabantur
241–279 ecs praecipiti ecs custodia quoniam timebant
280–323 ecclesiastici vicinos milites cum quilibet sciret
324–363 finire potestatem si monac*h*i possent attac*h*iare
364–405 illos et illicere carolis *h*ilaribus et sollemnibus
406–440 ecclesiae canticis servos a servitiis ut
441–478 emanciparent eos ecs ferocitate regis et ecs
479–522 potestate militum. Nunc Ocsoniae studebant milites;
523–559 ii armant se adversus ecclesiasticos. Trans-
560–599 portant milites Ocsoniae succursus militares
600–639 occulte. Idem fit deinde monac*h*is adversus *h*ostem;
640–684 milites detulerunt de crimine sc*h*ismatis ut conscios
685–721 arma tulisse. Milites timentes monac*h*os mire
722–761 ecscusant se principi; criminis poscant reos ut
762–805 fucum eorum inimicitiae struerent; ab eis provocati
806–841 sunt ut illos terrerent: fucus ille cedet in
842–879 viscum. Ecs eo januas claudunt ecclesiastici
880–922 et impedita ima posticia Baconi de Iscale et Rogero
923–959 ecsuli idem a Celtis de Cnocanis in Cnocania
960–999 civitate *H*iberniae praesidenda dicant. Milites
1000–1041 irriti ecsibant ad vadum T*h*amense ubi stetit domus
1042–1080 Minorum ecs rivo aequali. Vocs autem populi eos

[15] [Variations from Brewer's text are marked by italics, and rest mostly on critical notes given by Brewer. The preposition *a* is to be united with the initial of the next word, as in *a forti* = *af fo or rt ti*, or is to be read *ab*. Newbold's other variations are: *levi* for *leni*; *alcali* for *alkali*; *continentur* (ungrammatical!) for *continetur*; *salices* for *salicis*; omission of *serie* after *rerum*; *Hibero* for *Ibero*. Whether Newbold based any of these readings on a photograph of the manuscript, is unknown to the Editor.—RGK]

[16] [It is at this point that Newbold's annotation that at the time of deciphering he did not know whether the story was true or not, is attached.—RGK]

1081–1118 seponi ecs ripa ecs*h*ortatur. Postquam finivit
1119–1160 populus, milites faciunt salutationem militarem
1161–1195 sicut dederunt Cancellario militariter
1196–1238 consulenti. Id tra*h*it cleros ad revolutionem si illi
1239–1280 satisfecit ut idem titulus detur ecscellentibus
1281–1322 centum et secsaginta qui vitam reddant ut pillent
1323–1361 cleros et praesidi universi sc*h*olarum. Sanctis
1362–1403 non placet sanguinis effusio. Facit Bacon se mitti
1404–1445 in civitatem ut carbones salicis cum intinctione
1446–1486 aquae salis petrae et vino micstas ceu medicinam
1487–1523 menti suili emeret. Aprilis secundo milites
1524–1563 ecsierant ut ita seu fiat evitatio seu infectio
1564–1598 crimini ecscusus ille esset antiquus mos
1599–1636 cerevisiam et vinum sumi sincera in Kalendis
1637–1675 Aprilibus. In successu non fiet praeteritorum
1676–1714 inquisitio; crimina etiam macsima in successu
1715–1726 silere solent.[17]

[17] [Notes to the Text: The letter *h* is of course not represented in the cipher text, and is therefore printed in italics in the deciphered text. The *et* at 915–6 seems misplaced; the Editor suggests *Rogero Baconi de Iscale idem et ecsuli* . . . —RGK]

CHAPTER XV

The Gunpowder Formula

[The so-called Gunpowder Formula[1] is given in Brewer's printed text[2] as LURU VOPO VIR CAN UTRIET. With the context immediately preceding and following, we have

> Item pondus totum sit triginta. Sed tamen sal petrae *luru vopo vir can utriet* sulphuris; et sic facies tonitruum et coruscationem, si scias artificium.

Although the whole of this section is a cipher text, the upper text here makes in part a reasonable sense:

> Likewise the whole weight shall be thirty (pounds). But yet of saltpeter . . . [and] . . . of sulphur; and thus you will make thunder and lightning, if you know the trick.

The cipher words should therefore contain the proportions of the substances mixed to produce the explosive; and in fact when treated by the rules of the cipher they do yield such a formula. The twenty letters of *luru vopo vir can utriet* are not to be taken as forming several words, but as a single string of letters, of which all but the first and the last are to be doubled for the purpose of forming the biliteral symbols, of which there are accordingly nineteen, giving nineteen letters in the deciphered text. The decipherment is as follows:]

Text	L	U	R	U	V	O	P	O	V	I	R	C	A	N	U	T	R	I	E	T
Values		U	S	S	I	C	P	C	N	A	C	A	U	R	T[3]	I	S	R	I	I
							N					E		M		E	U	N		R
														S		S				

[1] [Most of this chapter is put together from scanty remains in Newbold's papers. —RGK]

[2] [*Op. Ined.* p. 551.]

[3] [The detail of the interpretation is copied direct from Newbold's note-book. Unfortunately there seems to be an error in the value of one symbol: *nu* is not T, and the presence of a T is vital for the last numeral. By the Tables of Values, *nu* is P,

```
u S S i C pn C                          C S C S (- X X )
u i Pn : N a C Ae U Rms t Ies S         C A R B O N I S
U I a t : rn I                          V I I
A T Rn : Ir                             T R I A
```

[Thus the formula reads: *sume*[4] *tamen sal petrae xx*, *carbonis vii*, *tria sulphuris*, or "take then twenty (pounds) of saltpeter, seven of charcoal, three of sulphur," proportions making a very respectable explosive. Yet I must add one qualification:] I can make the figures read 20, 7, 3, which is near the earliest known formula [for gunpowder, to be dated about] 1350,[5] [namely 6 : 2 : 1, or] 20 : $6\frac{2}{3}$: $3\frac{1}{3}$. But I am "making" the figures myself; i.e., they *may* be 20 : 7 : 3, but I cannot show that they *must* be.

[But the Gunpowder Formula varies in the manuscripts; indeed, Brewer in a footnote gives the reading of another manuscript, very different from that printed in the body of his text.] The three forms of the text [in the longer version, which are] in my possession, differ so much that it is probable that no one of them exactly reproduces the original. They are

(1) That given by Brewer, p. 551, note.
(2) and (3) Two photographs of English (?) manuscripts, neither identified,[6] but neither, I think, earlier than the fourteenth century.

Their texts are as follows:

(1) Brewer:
KB KA Φhopos pcαδικις ε. Γ. vel PHOSRIS.S.

---

rarely C or S; its graphic equivalent *nv* is E or N. The Editor ventures to suggest that the N of the Formula is an error for G or I; either *ag* or *ai*, replacing *an*, will have the value R which is used in the interpretation, and either *gu* or *iu* has the value T. The Formula then works out as above.—RGK]

[4] [For *s* and the sign of abbreviation in the manuscript, read *sume*, not *sed*.]

[5] See Colonel Hime's [*Gunpowder and Ammunition*, 1904, and W. R. E. Hodgkinson's] article on *Gunpowder* in the *Encyclopaedia Britannica*, [11th ed., vol. 12, pp. 723–724. Colonel Hime's attempt to decipher Bacon's formula, pp. 330–1 in Little's *Roger Bacon Essays*, resulted in the proportions 10 : 7 : 7.]

[6] [Perhaps meaning neither identical with Brewer's manuscript, from which he took the first version here given. The Ms A, from which the second version is taken, is British Museum Sloane 2156, and was seen by Newbold in 1923; he records that it is dated 1428.—RGK]

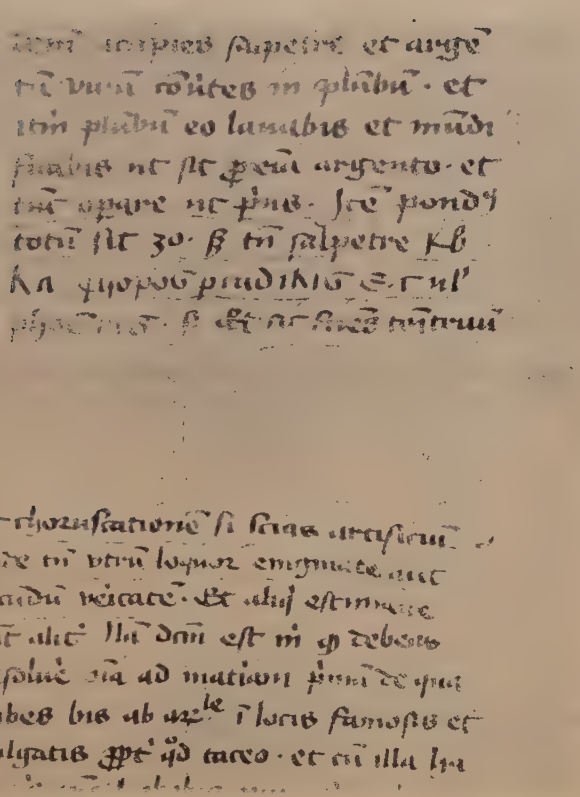
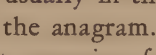


Plate XXVI

The Gunpowder Cipher: British Museum Sloane 2156

Courtesy of the British Museum

(2) Ms A:
κβ κα ψhopospcadiκis . Γnl'phosris˙.S˙.[7]
(3) Ms B:
RSR  oposp cadiRis.S˙. culphosRis.5.[8]

The text of Manuscript B, of which I have [a photograph of] about one half of one of Brewer's pages, differs considerably from Brewer's, usually in the direction of longer words, hence of more letters in the anagram. The underlying text must then represent a different recension from Brewer's, so that it would be merely waste of time to try to fit the longer formula into Brewer's text.[9]

[7] [This version of the formula accords with the Ms, of which a facsimile is here given, but is not precisely the same as that given by Newbold in Chapter IV, nor with that in his notes from which the above is taken. The difference from the notes is in the group of shorthand signs; the difference from Chapter IV is in the letters following Γ.—RGK]

[8] [Slightly conventionalized for purposes of printing. The R's may be K's.]

[9] [The Editor wished to add here a translation of the longer formula, but found in Newbold's papers only unfinished drafts, of which there were several.—RGK]

CHAPTER XVI

The Vatican Document

In November, 1921, I received a hand-copy, and at Christmas [of the same year] a photograph,[1] sent by a friend in England, of two pages, folio 27r and folio 27v, of a Latin manuscript in the Vatican Library, No. 3102. The first twenty-six leaves of the manuscript contain Bacon's *Perspectiva*, which ends in the middle of the second column of folio 27r, with the words *Explicit Perspectiva fratris Ro. Baconis*. The remainder of the column is filled with an entry in cipher, which is continued on folio 27v.

The conjunction of a work of Roger Bacon, the only man in the Middle Ages known by me to have studied cipher, who declares that all scientific men have been inspired by God to write in cipher, that the man is a fool who writes anything of importance in any other way, who declares his own intention to write in cipher—[the conjunction, I repeat, of a work by such a man] with a long entry in cipher, a rare phenomenon in itself, is sufficient to raise a strong presumption that Bacon is [himself] the author of the cipher entry. Comparison with other examples of ciphers attributed to Bacon converts the presumption into certainty. In both one finds:

(1) Nonsense passages. Compare the instructions [for making the Elixir, quoted at length in Chapter IV,] with the question and answer in this Vatican text: "Of what form is the shell of the egg conceived by the mixture of both in three first reclinings of *gtzlnd* upon the egg?" "He says that A."

(2) Meaningless letter-groups. Compare the group *gtzlnd* with the [final words of the sections of the *Treatise of the Three Words*, also quoted in Chapter IV.] Sometimes Hebrew letters and

[1] [The materials for the first part of this Chapter are the Letter to Provost Penniman, December 14, 1923, and copies of two earlier personal letters, dated August 16, 1922, and December 15, 1922. The latter part is transcribed with but slight changes in the arrangement, from some sheets which Newbold had prepared with great care and had distributed in photographed form to scholars who were interested in them.—RGK]

Tironian signs are mixed with the Roman letters, like the Greek letters and other signs in the Gunpowder Formula. The Vatican text contain also some word-signs not found in any other examples of Bacon's cipher.

Upon applying the alphabets to the first two words of the Vatican text, *incipiunt quaedam*, I got at once the first four words of the [true] title [of the section]:

```
In nc   ci ip pi   iu un nt   qu ua ae ed da am
 D  e    V  i  a    e  c  s    T  e  r  t  t  r
            e  l                      m        m
```

De Via ex Terr (a)—"On the Way from Earth," to Heaven, of course. But the presence of the word-signs made the deciphering of the text as a whole very difficult, and several months elapsed before I had even a tentative draft completed.

First, the Tironian signs. [There are five of these in the manuscript, with a sixth which is made up of a combination of three separate signs.] But before I ventured to assign them values, I spent several weeks deciphering facsimiles [of manuscripts written in these signs,] in order to become familiar with the permissible variations from the lexicon-types, [such as would be] assumed by the characters when written by different hands and in combination. I am therefore quite convinced that the letters which I have distinguished are different letters, no more likely to be confused than letters of the Latin alphabet, except that in two or three instances the imperfection of the photograph leaves it uncertain whether the horizontal line is straight or curved. [The combination of three signs making] the word *atterit* is as clear and as carefully written as a Tironian sign could be; every stroke is perfectly distinct.

[Secondly, when I did make a tentative interpretation,] the document proved to be an exposition of the system of symbolic logic which Ramon Lull, the Catalan mystic, philosopher, poet, missionary, and martyr, received, as he believed, by divine revelation in the Island of Majorca about 1274. The character of the subject-matter greatly increased the difficulties of translation, for Lull's system is obscure in the extreme. I knew nothing of it, his works are very rare, about half of those I could get were in Catalan, a language which I did not understand. [Accordingly,] before I could proceed with the decipherment, I had to learn Catalan. I

read about one thousand pages in that language and as many more in Latin, [writings by Lull and writings concerning Lull. For if the decipherment is to have any claim to acceptance, I realized that] the attribution of doctrines to him [must be shown to be] warranted or at least not negatived by what is known of his times. This, [naturally,] I have tried to do for every document that I have translated.

[I would emphasize the point that] nowhere in my notes, [given later in this chapter after the deciphered text,] is there any hint that Lull used cipher. The notes open with a brief exposition of his sytem, the general tenor of which is sufficiently indicated by two quotations from it: "Lull's *Ars* is the first symbolic logic . . . Lull connects letters with concepts, as does Kabbalah, but with different implication. They are symbols which facilitate logical operations." There follows a quotation from Lull proving the statement.

As it was impossible to read this document at all without being familiar with Lull's system, I found in it only two statements of fact unknown to me, [which may serve as proof of the correctness and validity of the interpretation,] but these two are so striking that they should not be omitted.

(1) The word *cupa* occurs five times, and in three of the five [occurrences] it is written with no disarrangement of the letters, thus:

```
1: po os st te ea          2 and 3: sz zz zs sy
     C  U  P  A  M                   C  U  P  A
        c  c  m  e                              e
```

The word is a rare one; it means a *barrel* or *cask*; the context shows that it is here used as a symbol for the *human body*. Now in many of the drawings of the Voynich Manuscript, objects showing barrels are shown; [and] until I deciphered the Vatican text, neither I nor any of the many scholars to whom I showed them could suggest any meaning for the symbol which would make the pictures intelligible. This meaning makes them *all* intelligible. [The description accompanying Plates IV and VI, in Chapter III, give a more detailed interpretation of the term, in connection with the drawings of the *cupae* in the Plates.] I think it likely that *cupa* is a translation of Plato's *πίθος* (*Gorg.* 493), or perhaps of Porphyry's

ἀγγεῖα "vessels," by which he designates the "astral" bodies of the souls. It remains to prove that Lull knew the doctrine [symbolized by the *cupa*] and used the word (it is not used in those of his works to which I have access), [or] to trace out the channels by which the word reached Bacon.

(2) The Vatican Text attributes to Lull the doctrine of the pre-existence of the soul; that it is "something from God's own bosom." When I first deciphered this, in March or April, 1922, I thought it contradictory to the doctrine which I found in Lull's works, that the soul is created by God, and I pointed out the contradiction in my notes. But in August [of the same year] I discovered a paraphrase of Lull's *Lectura super Figuras Artis Demonstrativae*,[2] [which stated;] "Suivant Raimund Lull, l'âme a trois degrés d'existence. Le premier degré est *l'existence de toute éternité qu'elle a en Dieu*; le second, l'existence qu'elle a, après la création, en tant que spirituelle; le troisième, l'existence qu'elle a en tant qu'unie au corps pour constituer l'homme." In September, 1923, I was able to consult the British Museum's copy of Lull's works, and there found, on page two of the third volume: "S (i.e., the rational soul) exists in three grades. The first grade exists from eternity in that idea which is A" (i.e., is God).

Before one can accept as a fact the acquaintance of Bacon with Lull's works, thus revealed, it must be proved to be possible. Hitherto no connection between Bacon and Lull has been known, and I myself thought it very unlikely. Lull was nearly twenty years younger than Bacon; his first book was written only two or three years before Bacon's imprisonment, and it was written at Majorca while Bacon was in Paris. But in *Acta Sanctorum*, XXVII, 608, the life of Lull written about 1310 either by him or with material supplied by him, relates that after writing his first book he was invited by King James,[3] whose friend he had long been, to come to Montpellier in France and show it to him. The King referred it to "a certain brother of the Order of Friars Minor." The brother reported favorably—a circumstance which led Lull

[2] Printed in *Histoire Littéraire de la France*, tom. 29, pp. 123–4.

[3] [James II (1243–1311), King of Majorca, inherited the Balearic Islands from his father James I of Aragon. He was engaged in constant conflict with his brother Pedro III of Aragon, and in alliance with the French king against his own kin. *Encyc. Brit.* XV 142.]

throughout his life to regard the Franciscans as his friends and protectors—and soon thereafter the King gave Lull land for his proposed college. The deed for this land still exists; it is dated 1275. It is therefore quite certain that in 1275, two years before Bacon's imprisonment, a brother of his order in France reported favorably upon a book which professed to contain a new system of philosophy, expressly revealed by God for the conversion of the Mongol and the Saracen, and thus to avert from the Christian world the Asiatic peril which then filled all minds with dread. One may be quite certain that this thrilling news was not unduly delayed in reaching the chief house of the Franciscan Order in Paris, where Bacon then was.

[The interpretation of the cipher texts of this Vatican Manuscript is now given, accompanied by such notes of various kinds as are needed for its exposition.[4]]

[THE NATURE OF THE CIPHER OF THIS TEXT:]

The cipher is Bacon's usual Latin cipher with two new features—cipher characters to represent syllables and words, and free use of the meaningless letter groups used occasionally elsewhere (in the Gunpowder Formula and in the closing lines of the Chapters of the *Trium Verborum*). These made necessary, not only the determination of the values of the characters, but the solution of four new problems. The following solutions, being based on such scanty materials, are tentative.

(a) Correction-symbols in the text are part of the cipher; e.g., the ∧ [must be read] *caret* or *carent*; *zz* [with dots underneath (meaning "expunge") must be read] *zzecspunctis*.
(b) When two or more words are expressed by one character, final and initial must be juxtaposed to form a new symbol; [e.g., *soloriens* as if one word.]
(c) Words so expressed are not inflected, except correction symbols.
(d) The flourish appended to the Tironian signs is a mere ornament.

[4] [This text is given in detail as being the only document which Newbold left with a complete commentary. No changes have been made, except that of arranging portions for easier composition in type.—RGK]

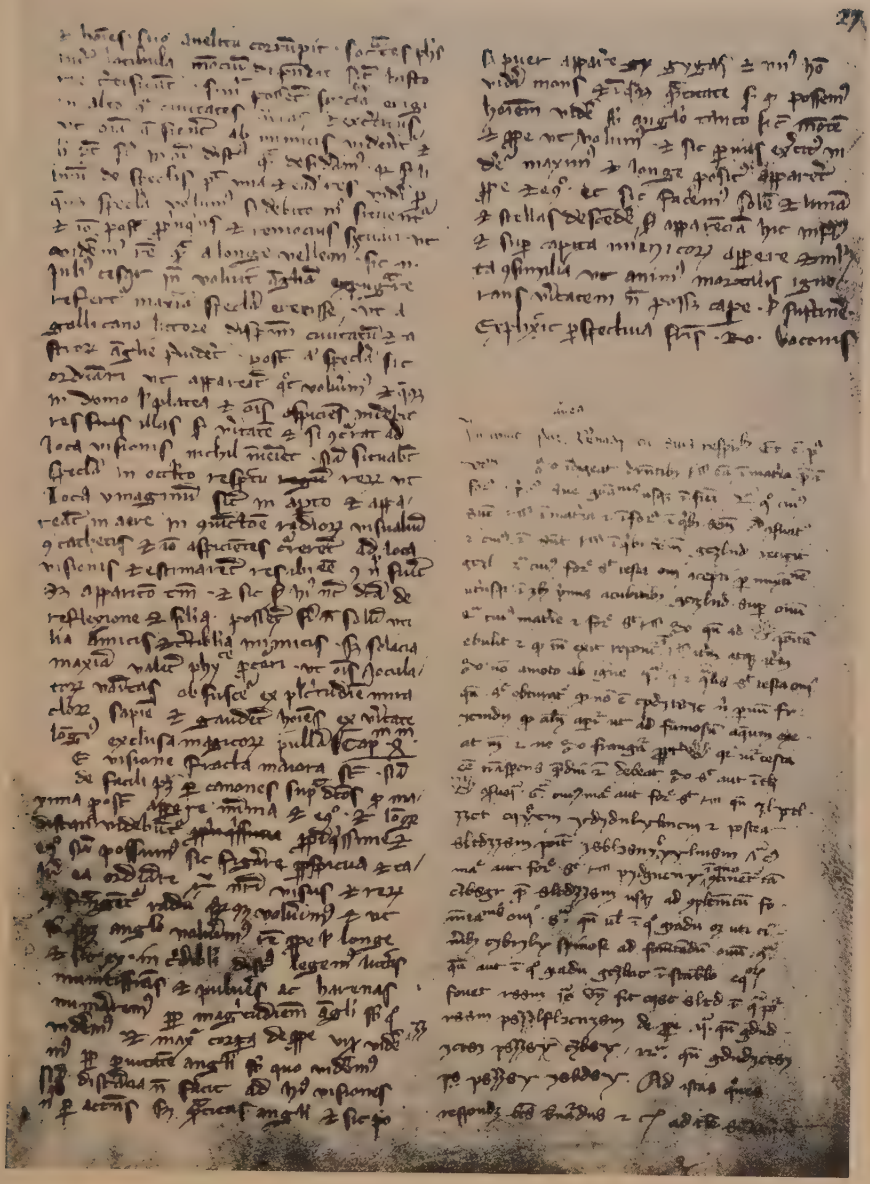


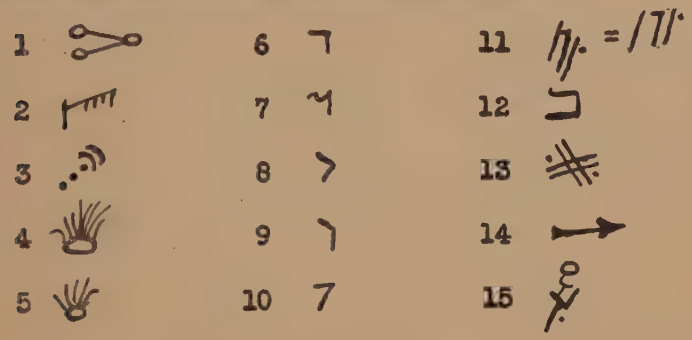
Plate XXVII

Vatican Manuscript, Lat. 3102, folio 27 recto

Courtesy of the Vatican Library

The frequent occurrence here of biliteral symbols which for phonetic reasons never occur in Latin [words] has made possible the verification of their theoretical values. The *y*-symbols show that *y* reverts to *i* (and not to *a*). *U* and *v* are found to differ as *characters* only, not as vowel and consonant; hence either, when occurring in a symbol, may be taken as the other.

[Special Cryptographic Characters in this Text:]



[The following are the values of the special characters used in this piece of text, with numerals referring to the Figure:]

1 = *mucinesra*: it is the Greek alchemical symbol for *arsenicum*, written backwards. (BEC 108) Occurrences, 6.
2 = *paragraphus* (CD 412) Occurrences, 8.
3 = *tria-puncta-et-duo-quadrantes* (conjecture) Occurrence, 1.
4 = *sol-occidens* (conjecture) Occurrences, 3.
5 = *sol-oriens* (conjecture) Occurrences, 3.
[6–10, Tironian signs:]
6 = *ti* (CNT 35) Occurrences, 13.
7 = *ri* (CNT 27) Occurrences, 3.
8 = *la* (CNT 16) Occurrence, 1.
9 = *li* (CNT 17) Occurrences, 3.
10 = *te* (CNT 35) Occurrence, 1.
11 = *atterit*, three Tironian signs: *at-te-rit* (CNT 4, 35, 57) Occurrence, 1.
12 = *beth* (Hebrew letter) Occurrences, 5.
13 = *asteriscus* (CD 412) Occurrences, 2.
14 = *spiculum* (conjecture) Occurrences, 2.
15 = *ymnus* Occurrence, 1.

[The abbreviations used here are the following:]

BEC Berthelot, *Introduction à l'Etude de la Chimie des Anciens et du Moyen Age*, Paris, 1889.
CD Capelli, *Dizionario di Abbreviature*, ed. 2, 1912.
CNT Chatelain, *Introduction à la Lecture des Notes Tironiennes*, Paris, 1900.

[The] letters *a* to *g* [, when standing alone, are to be] read *aa*, *be*, *ce*, *de*, *ee*, *ef*, *ge*.

[Explanation of the Arrangement:]

TC = cipher-Latin text.
TD = transliterated but disarranged text.
TR = recomposed text, i.e., translation.

[The numeral at the beginning of the first line gives the number of symbols included to the end of that line of TC; this is followed by the TC in minuscules. Letters substituted for cipher characters are in italics.

The second line gives the TD under the corresponding symbols of the TC; values used in that line are given in capitals, while values not used are in minuscules and are carried down to the beginning of the next line of TD as a remainder. But alternative values of characters used are also in minuscules, following without gap the values used to form the TR. Italicized capitals in the TD mark values used at an earlier point in the TR; see tabulation after the text.

At the end of the second line, or below if it lack of space requires, is the TR, followed by a numeral giving the number of letters to that point. Italicized letters in the TR indicate values coming at a later point in the TD; see tabulation after the text.

The numeral at the beginning of the line, less the number of values carried to the next line, equals the number at the end of the line, less the number of values used but coming at a later point in the TD.

The device of putting the phonetic values of the symbols when they are used, in their actual values in the TR (for example, P or B or F), is] adopted to make the word-groups more obvious to the

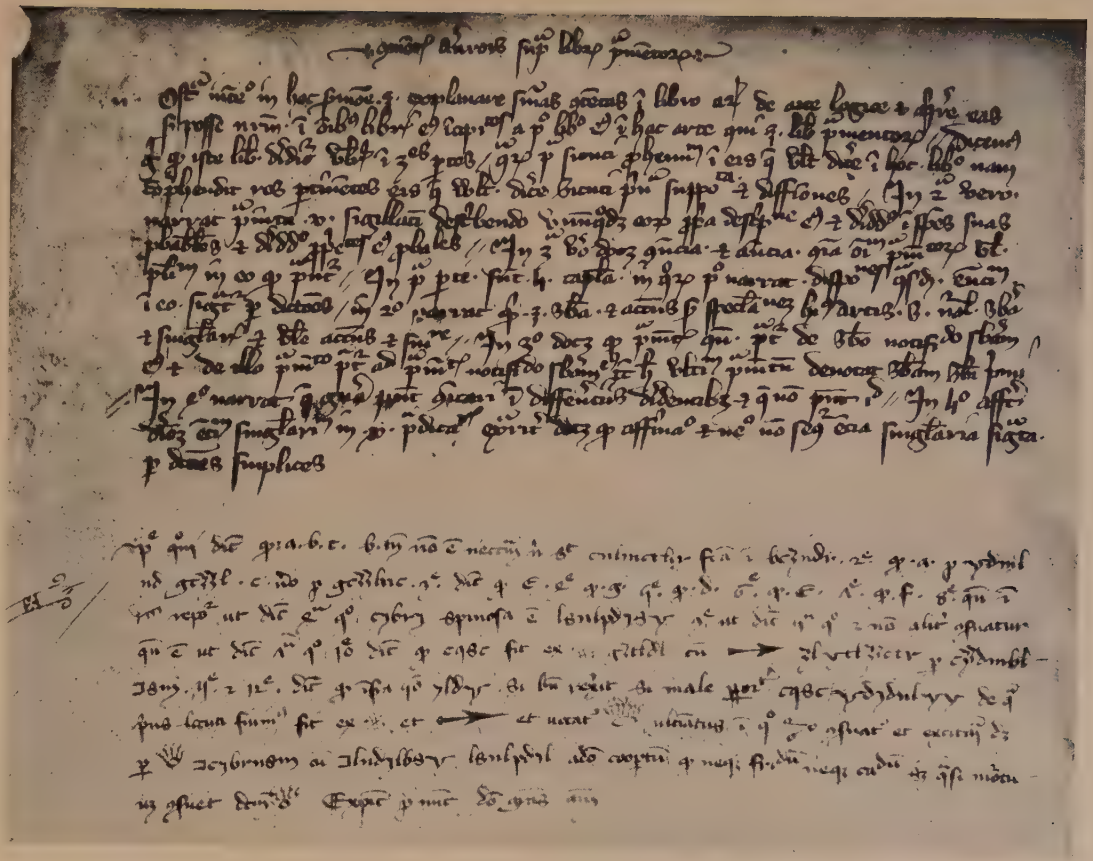


Plate XXVIII

Vatican Manuscript, Lat. 3102, folio 27 verso

Courtesy of the Vatican Library

eye; but it must not be forgotten that it is no less artificial, [and no less] an addition to the cipher, than the use of capitals for the same end, and that both make the cipher seem less ambiguous than it in fact is.

[VATICAN MANUSCRIPT, LAT. 3102, FOLIO 27 R, COL. 2, PARAGRAPH 2:]

```
8  i n c i p i u n t
     D E V Ie Al E C S                    DE VIA ECS        8

14 q u a e d a m
   : T E Rm t t Rm                        TERRA             13

29   c a r e t   q u a e s t i o n e s   B e-
  D t : O C le il     t E Lm i pc pt Ai O A i     S
                                          AD COELOS.        21

33                 -e r n a r-
  D le Il T I pc Pt I : i S mr C           DISPICIT          29

39          -r d i    c u m    s u i-
  re-pc I Mrs : t t      T S      C A     MICSTA            35

54        -i s   r e s p o n s i o n i b u s   e t
  re Pc t t : I     Re I P C u N l Ai u e lm mc p    Il
                                          PRINCIPIA         44

58                     e s t    p r i-
  re t t u L U E lm Mc p : i cp     c N    LUMEN             49

63                 -i m a    u t r u-
  re t D U Lm P i Cp c : urm mr     Es u S  DUPLECS:          56

63
  re t i c Urm Mr U :                     UNUM              60

68       -u m    m u c i n-
  re t i c : s      S E u T               EST               63

69          -n e-
  Re T I c S u : A                        ARTIS,            68

89  -e s r a   i n d i g e a t   d i f f e r e n t i b-
  c u : I s n     T El T S Rm Rm E    t A s t i Le E s pt Rm
                                          TERRESTRIALE;     80

90                 -b u-
  C U S N D s t i s pt : Mc               SECUNDUM          88
```

100 -u s *p a r a g r a p h u-*
s t I s Pt : P R C N Ml cm *N* I e I
PRINCIPI*UM* 98

100
S T s cm E : EST 101

113 *-u s* t a m i n m a t e r i a q u a m
s cm : p A Ml t Ml E Am I n Lm T E Rm
IMMATER*I*ALE. 112

119 i n f o r m a a *p*
s cm p t n : t *U U E*ns ml *I*

125 p r i n c i p-
s cm p D n T ml : G N T E U Ei DETEGUNT 120

139 -p i o s u a e g e n e r a t i o n-
s Cm p n ml : ra Ia C e Ml Ml E A i N e Tp Ia O
COMMENTICIA 131

147 -n i s u s q u e i n f i-
s p ml Ra E i N e : E i P Ea T pm T T
ET REPET*U*NT 141

154 -i n e m s e c u n-
S P Lm I e I pm : t A t al I t C SI*M*PLICIA 150

165 -n d a c o n i u n c t i o
E pm T t Al D : El t n u e e C E N Tp Ia
ET DECENTIA 160

181 c u i u s s u n t *p a r a g r a p h u-*
Pm T t n U E e : t a ec P c c S R C N lm mc n I e I
E PR*I*N*C*IPIIS UT 173

181
T N E t a E c c L M n E ELEMENT*IS*. 182

195 *-u s* in m a t e r i a e t i n f o r m a
t a c c n : p t rm e am *I* n rm *I*l t o *U* sen *M*l

195
T A c c n P T Rm e Am N Rm t O Sen TRANSPORTA 192

205 i n q u i b u s s e m e n
c c N E T : t t A Lm Mc p al t E E
ELEMENTA 200

207 *t r i-*
C C T t p Al t : Us N CUNCTA 206

214 *-i a - p u n c t a-*
D F t : Ml I C c E n A AD FACIEM 214

226 *-a - e t - d u o - q u a d r a n-*
T c N : Ml Il R Ie S ce t e A u n Slm
SINISTRAM 223

229 *-n t e s*
c Ce D E U N : S Am I SECUNDI. 230

239 c o n s e r v a t u r
C : N U N al I cp u e u S NUNC 234

242 e t c u i-
al cp u e u : Il T A ITA 237

244 -i u s
Al Cp u e u : ec F FAC 240

248 e t i a m
u e U Ec : Il Tp Rm Ml ITERUM 246

262 s u n t *p a r a g r a p h u s* i n
u E : C c S R c n ml cm n i E I p T
CETERIS. 253

264 q u i-
u c c n ml cm N I F : T A FIANT 258

271 -i b u s s e m e n
U c c n Rm Cm : Lm Cm P Al T E E RECEPTACULA 269

281 g t z l n d r e c i p i-
c C N : Ci Oc U c el el I u ie Al CONIUNCTA 278

288 -i t g t z l t e r t-
c c Le El u ei : Icu Ic uc u Am i Si
LINEIS 284

302 -t i a c u i u s f o r m a e s i t t e-
c c u ei cu u i : tp Rm t A Ec P u u Ns Lm Lm L Icu Am
PARALLELIS, 294

306 -e s t a o u-
c C O ei Gu O I Tp T u u : i cp A Np OCTOGINTA 303

314 -u i c o n c e p t i
Q ei U U i pc : A N O e u Ric p Tp
QUATUOR 310

322 p e r m i c s t i o-
Ei i pc e o p : Epa i Tml i R Cp Tp Ai
RECTA ET 317

327 -o n e m u t r-
i Pc e O P I i : O A T Se *S*u OPPOSITA 325

342 -r i u s q u e i n t r i b u s p r i m-
I E i : N Ec P Ae D Mp D Us n Rm Cm P c n Ulm
AD PERPENDICU*L*UM 340

355 -m i s a c u b i t i b u s g t z-
i n G N : Tml I I *T* n *L*m Icu pt ml cm p ic Uc
VIGINTI. 347

358 -z l n d
I N n pt Ml Cm p Ic : U c El INVICEM 354

364 s u p e r o u u-
N pt p c : C In Ep I Bn S INSC*R*IBE 362

370 -u m q u a r t a
Pt p c : S t E C Is A APICES 368

380 c u i u s m a t e r i a-
P c T : t A Ec B Lm e Am I n *R*m ALPhABETI 376

385 -a e e t f o r m-
C D E N : Ml il U U Sen SECUNDUM 384

389 -m a e s i t
Il : Lm Lm L Uic LULLI 389

399 *p a r a g r a p h u s*
: R C N ml cm n I e I P PRINCI*PIA* 398

407 *m u c i n e s r a*
ml Cm N E : S e O t a i s N NON ECS 404

409 q u a-
Ml E T A I S : T E METAThESI 412

429 -a n d o a d *s o l - o c c i d e n s* p o s i t u m
: mls el ei *A* *In* *Pa* Ce Q Ui u E U e N C Uc r Icu U S
CUIUSCUNQUE 423

439 e b u l i t e t q u o d i n-
Mls El Ei U e r : S Cm S N Uic li D s al D
SED SECUNDUM 434

444 -n d e e c s i-
e r li s al : Le U I L L LULLI 439

448 -i t r e p o-
E R Li S Al : Uic re icl G REGULAS 446

455 -o n i t u r *c a r-*
Re Icl : U E Icu U S U C CUIUS VERI 455

470 -*r e t* i n *p a r a g r a p h u s* i t e-
: el il t R c N ml Cm n I e I P I Am
*P*RINCIPIA, 464

475 -e r u m a t q-
el il t c ml n e : I S s E A SI EA 468

482 -q u e i t e r u m
El Ri t C Rm n E S : t *P*m Icu Am I S S
ARCESSIERIS 479

489 *m u c i n e s r-*
t N T : S E U T a i S ESS*E*NT UT 487

493 -*r a* n o n a m-
D A i : n S O Lm SOL AD 492

503 -m o t o a b i g n e q u i n-
I N : E Ec ap Mlt S T A T A T
SANITATEM ET 503

508 -n t a q u a e
Ap : S A D *E* Rm ARS AD 508

521 e t q u a l i s s i t t e s t a o v-
: Il T e Ac N I R Oic Ma i Gp A Np
IGNORANTIAM. 519

532 -v i q u a n d o s i c o b t u-
e i : a D E Sml Re ei L I n ia U
DELIRUS 526

537 -u r a t u r
e i a ei n ia : S N E U S SENSU 531

542 q u o d n o n
e i a ei N ia : t S Al S O SANOS 536

550 e s t c p d *t i* t s-
e I a ei ia t : i Fc Nl n I Tp icu Gp
FINGIT 542

561 -s *t i* c n i s i p a r v u m
e a Ei Ai T I n Oic : Cp Tp i e i l l c Cp S S
ECSTATICOS, 552

561
e a n i E I L L c : ILLE 556

567 f r *t* *i* c m d-
E a n i C : Ia Si Dp I T Pm DESPICIT 564

578 -d i i q u o d a l i q u a n-
A N I : T S t s la Ac n i T E Mls
SANITATEM 573

587 -n d o a p e r i t u r
t S la n i : le Ie i Epa I n Uic u S SI EIUS 579

594 u t a l i q u o d
t la n i le I N u : Se Ac N I T S Al
INSANITAS 588

605 f u m o s u m a q u o s u-
D la n i El u : u s e uc C s I T S Uc C
SUCCEDIT. 596

606 -u m
la N i u u S E Ùc S : S SENSUS 602

609 e c s e-
La i U U : i L La LULLUS 608

616 -e a t i n d e e t n e
I I : Ml E T Le u li A ELIMINAT 616

624 *m u c i n e s r a*
O Li : S e U T a i *S* *N* UT SOL 621

627 f r a n-
e A i : Ia n Mls IAM 624

634 -n g a t u r p r o-
E I N : E Lm e u S C Se ECSILIENS 633

647 -o p t e r *s o l - o r i e n s* q u-
e O : Np p am i *In* Ap Ec o N i E N T
A NON ENTE 641

649 -u i a
e p a i U I : A Ml VIAM 645

655 v i d e t u r
e p a i : a E u Il U S EIUS 649

658 t e s t-
e F A I a u : am i Cp FACIT 654

676 -t a e s s e t r a n s p a r e n s q u a m d-
E a U Am I : a I u La us N Mls N p L C El e n T E Lm Tpn
IN INTELLECTUALEM 670

685 -d i u e t i a m d e b e-
A A u Us B e N : T e Il Tp Ml rm u S S
SUBSTANTIAM 681

686 -e a-
u e E Rm U : Ml RERUM. 686

695 -a t *m u c i n e s r a*
u E : E S e u T A I S N ESSENTIA 694

702 s i t a u t i n t h e-
u E O : *R* Icu T se D n Ml
METhODI 700

707 -e s a u r o
u se n : I N T S Es EST IN 705

717 *s o l - o c c i d e n s*
U Se n : in ap ec C Ui O e U E N SENSU VOCUM. 715

724 c o n s e r u a-
N In ap ec e : n o n al i S E IN SE 719

727 -a t u r
Ap Ec e N O N Ra i : E U *S* VERAE, NON 727

742 s e c s t a c u i u s m a t e r i a-
E I : Al I R Bc A T A ec p Rm e am i n Rm
ARBITRARIAE, 738

750 -a e a u t f o r m a e
Ec P E Am I N : Rm T se U u ens Rm Rm
REPERIANTUR 749

754 s i t *p a r-*
Se u Ens : l icu l C ECS 752

762 *-r a g r a p h u s*
O R Icu l : N ml Cm n I e I P PRINCIPIO 761

770 q u a n d o *a t t e-*
L Ml N E : T E sml Re Ie E O Am ELEMENTARIO, 772

778 *-e r i t* l p t l z-
sml : I N Uic c cp *P* C O UNICO, 777

784 -z z c t c q *y m-*
Sml c Cp : o A N i O T SANCTO. 783

792 *-m n u s* c m y d *t i-*
C o I : ns C P A t T I *Tp* ACCIPIT 790

798 -*i* d n b y h n-
o Ns t : e Ia A S Ml Uicm ANIMUS 796

800 -n c m
O D E : E D DE DEO 801

806 e t p o s t e a
: il C Uc Pc Am Ml CUPAM, 806

814 s l t d z z s m p o-
il : Se np R O U P ne C CORPUS, 812

819 -o n i t u r
Il np ne : o E ciu U S EIUS 816

824 *r i* s b l *b*-
Np Ne O Ciu : N I al I L NONNIChIL 824

828 -*b e t h* s-
Al : S Il N U A SINU 829

849 -s n t i *c a r e t* l y y l m s m s e p t i m a
: C S am I U C el il C R s i c ac ne Ra Icl P Tp Uml Ml
CIRCUMSCRIPTUM 843

855 c u i u s m a t-
am El il S i c ac Ne : t a ec P Rm E PER ENS 849

866 -t e r i a e a u t f o r m a-
Am Il i c ac t a ec : Am i n Ml Rm T Es u u Ens Lm
MATERIALE, 858

867 -a e
i Q Ac T A ec I N U U : Ml QUIA, NATUM 867

870 s i t *p a*-
I Ec : L Oic L ILLO E 872

880 -*a r a g r a p h u s* p *t*-
: C N Rm mc n I e I P P PRINCIP*IO*, 881

892 -*t i* d g n c n y *c a r e n t*
mc n e : tp e t t e t a O C El E S
ECS EO 886

898 i n q u o c o n t-
Mc N E Dp E T T e T A : t t S n U S
DEST*I*NATUM EST 899

908 -t i n e n t u r c a e t-
E t t N : Ft D A e s u s u Ml Il AD FINEM 906

916 -t e r a c z b s g r
t T E S U S O : am I N R R Ie R Cm RESURRECTIONIS 920

923 q u a n t u m s l-
t am : t E Slm s u S Es ESSE 924

936 -l c d z z s m u s q u e a d c o m-
T Am t S U : a i O O P Ne P *Ea* t *Mp* a N Nla
NON SUPPONAT 935

941 -m p l e m e-
t A I T A : C C l D E ACCIDENT*IA*, 945

957 -e n t u m f o m e n t a t i o n i s
t l : e s u s *O* *N*la e e s a e tp *I*a o e *I*

957
t L E s U s e E S a e tp u e LEVES 950

959 o v i
t s S e A e tp U E : Np A AVENAS 956

967 o c t a v a q u a n-
t s e e tp : C N A D E T E Sml CADENTES 964

974 -n d o v e l i n q u o
t s e E tp : Le Ie Mp I T t S
LIMITES 971

977 g r a d-
t S E Tp t : Cm n A ECST*R*A 977

984 -d u o p o r t e t
T T N : E pn c U Si am I ENTIS UT 984

991 u t i c i n e r i-
Pn C Am : es Tp U t a i N PUNCTA 990

995 -i b u s c *t*-
es T A I : lm Qm p N Q*U*ANTI 996

1007 -*t* *i* b r *t* *i* l y s p i n o s-
Es Lm p : pt Ml I Is Tp cm l p al t S *U*c
LIMITES. 1003

1015 -s a e a d f o m e n t-
p Pt Gm L p Al t : N *R*m A u anl e E S
PhALANGES 1011

1020 -t a n d u m
p P T U Anl E : A Sml el ei S ASSU*M*PTAE 1020

1027 o v u m n o n a q u-
p el ei : Np s s s U Sml T SINT UT 1026

1032 -u a n d o a u-
p El Ei S S S : E Sml El ei T ESSE ESSET 1035

1042 -u t i n q u o g r a d u g t z-
p ei : Es D T S Gm N A Is ic U
DESIGNATUM 1045

1046 -z l n t i n
P ei Ic : U C S T CUPIS 1050

1062 s t a b u l o e q u o r u m f o v e t
ei : pc a Mlt mc s ec I t s u s s o c Mp Il

1064 r s s-
Ei pc A Mc s Ec t s U S S O C : s U A VOCUM ESSE. 1060

1065 -s m
pc S T s s : En EST 1063

1070 d e c i m a
pc s s : U I U Uml Ml VIVUM 1068

1072 u n d-
pc s S : C El ECS 1071

1079 -d e f i t c q s c s l-
Pc s : O T Icu O R a Es
POTIORE 1078

1084 -l t d i n q u a
S A : Pn R t t E SPhERA 1083

1090 p o n i t u r
T T : c U E Uic U S UT VETUS 1090

1096 r s s m p s z z-
c : S U ne C C U SUCCUS 1096

1103 -z *e c s p u n c-*
c ne : L I L p c c E ILLE, 1100

1113 *-c t i s c a r e n t* z-
c Ne P C C : n Tp i A O c El e S Uc OCCUPANTE 1109

1124 -z z l f l *b e t b* c n z-
C N I c e : O u e ai l s il n O T Cp INCOCTO 1116

1124
c E O E Ai L s il N : LENAEO 1122

1127 -z s m d e
C S il : P ne U CUP*A*S 1127

1138 p r o p o s i t i o n e
Il Ne : Q es np c oc l Uic t ia O *A* IN QUO 1132

1138
es Np C Oc L Tp Ia : *I*NCOLIT 1139

1145 u n d e c i m a
es : c le U I U Uml Ml VIVUM 1144

1149 q u a n d-
Es G Re : T E sml El GENERET, 1151

1157 -d o g d n d *t* *i* c t-
Sml : ei e Ia el I Dp i *N* SI*C* ID 1156

1161 -t s *t* *i* p s-
ei e El I : Fc Fc Tp C EFFIC*I*T 1163

1165 -s z z s y
Ei e : C U P Al CUPAE 1168

1169 c z b s y
E : L L Ie Al ILLAE. 1173

1177 d u o d e c i m a
: ei S al U I U Uml Ml S*I* VIVUM 1180

1180 q u a n-
Ei al : t e Sml SE 1182

1190 -n d o g d n d *t* *i* c t s-
Al T E : El ei e Ai el i Tp I N Pc PAENITEAT 1191

1204 -s *t* *i* p s *e* *c* *s* *p* *u* *n* *c* *t* *i* *s* p s-
Ei e el I : Pc Tp C Al *I* l p c c e n tp i C
PECCATI, 1198

1204
e El l P C C e N Tp I : PECC*A*NTI 1206

1208 -s z z s y
e l e : C U P Al CUPA 1210

1217 *t* *i* s b d s y a d i s t-
E l E : Tp I *A*l T *I*a la a *I* *C*p
hIET ET 1215

1223 -t a s q u a e s-
l la a : A Cm T E Ml I EMICAT 1221

1228 -s t i o n e-
l la a : cp Tp Ia U A VITA. 1225

1230 -e s r e-
l la A Cp : i El hAEC 1228

1238 -e s p o n d e t b e-
L La i : i p c U Le U il S LULLUS 1234

1239 -e a-
i I p C Il : Ml MIChI 1238

1243 -a t u s B e-
I P : E u p S IPSE 1242

1249 -e r n a r d u-
u F : I s *M*ls C T Ei FECIT 1247

1257 -u s e t c a e t e r a
u s : p il O Ml Il Am i N OMNIA 1252

1268 a d c l e r i c o s s i m u-
U S p il i : A l l I N i N cu l uml S
(INSANUS!) 1259

1276 -u l s e q u e n t e-
p il I L L i cu l Uml : S Ra I T pm e s Am
ILLUSTRIA 1268

1277 -e s
P Ri I Cu R Bm E S : I PERSCRIBI. 1277

[For easier comparison with the facsimile of the manuscript, the following division of the text according to the lines of the original is given:

Line	begins		ends		Line	begins		ends	
1	Inc-	1	-ima	60	15	*sol-*	708	-tl-	777
2	utr-	61	in	114	16	-zz-	778	-tea	806
3	for-	115	-ius	169	17	slt-	807	-ius	853
4	sunt	170	-tur	239	18	mat-	854	-tur	905
5	et	240	-pit	282	19	cae-	906	fo-	946
6	gtz-	283	-nem	325	20	-me-	947	ci-	987
7	utr-	326	ovum	365	21	-ne-	988	nona	1026
8	qua-	366	-tum	429	22	qua-	1027	-rum	1058
9	ebu-	430	-rum	482	23	fov-	1059	-tur	1090
10	*muc-*	483	ovi	522	24	rssm	1091	-nd-	1153
11	qua-	523	fr-	562	25	*-ti-*	1154	*-sti*	1192
12	*-ti-*	563	exe-	609	26	ps*e-*	1193	-nes	1229
13	-at	610	-sta	659	27	res-	1230	-tes	1277]
14	esse	660	-uro	707					

[The following letters come in the recomposed text (TR) before they are found in the transliterated text (TD):]

A 13 - 27	L 338 - 348	I 891 - 957
N 58 - 97	R 359 - 380	E 913 - 931
E 82 - 117	P 396 - 415	N 942 - 947
U 87 - 115	I 397 - 414	I 944 - 1062
U 97 - 116	A 398 - 413	R 976 - 1009
I 109 - 119	P 456 - 477	U 992 - 1007
U 139 - 193	E 483 - 507	M 1016 - 1061
M 144 - 195	S 608 - 623	I 1022 - 1053
I 164 - 187	N 614 - 624	T 1026 - 1046
I 167 - 190	I 630 - 639	M 1045 - 1246
I 181 - 234	T 654 - 792	S 1096 - 1112
S 182 - 239	R 682 - 696	A 1126 - 1138
A 210 - 228	S 709 - 727	I 1133 - 1195
A 269 - 286	M 715 - 933	N 1147 - 1157
N 275 - 297	P 753 - 776	C 1154 - 1217
T 277 - 346	M 835 - 1049	I 1162 - 1213
N 281 - 308	I 880 - 954	I 1175 - 1216
S 294 - 327	O 881 - 946	A 1203 - 1211

Introduction [to the Notes to the preceding text]:

Abbreviations:

L Lull.

LO *Opera ea quae ad . . artem universalem* etc., Argent. 1598; contains *inter alia*,

- LOAM *Ars Magna.*
- LOK *De Auditu Kabbalistico.*
- LOO *Oratio Exemplaris.*
- LOOP *Duodecim Principia Philosophiae*, or *Lamentatio Philosophiae.*
- LOR *Isagoge in Rhetorica.*
- LOAF *De Articulis Fidei.*

LQS *Disputatio Heremitae et Raymundi super aliquibus dubiis quaestionibus sententiarum*, Ven. 1507 (lent by W. M. Voynich).

LR *Obras rimadas de Ramon Lull*, ed. G. Rosselló, Palma, 1859 (life and fourteen Catalan poems).

LAC *L'Art de Contemplació*, ed. J. H. Probst, in *Bäumker's Beiträge z. Gesch. d. Phil. d. Mittelalters*, XIII, parts 2–3 (1914).

LD *Declaratio Raimundi*, ed. P. O. Keicher, in *Bäumker's Beiträge*, VII, parts 4–5 (1909).

Lull's System: Ramon Lull, mystic and philosopher of Majorca (1235 ?–1315), believing his *Ars Generalis* had been given him by inspiration (LQS 21: *Respondit Raymundus: cogito, inquit, de quadam arte generali quam mihi Deus in quodam monte ostendit*), never quotes "authorities," yet does not demand its acceptance upon that ground, but trusts to its appeal to human reason. Study of the system reveals, in its novel features, traces of two major influences, the Kabbalah and Aristotelian logic. L often mentions

Plato and regards his own philosophy as the completion of Plato's (LOK 112: .. *est perfectio philosophiae Platonis ... ubi philosophia Platonis desinit ibi incipit Kabbalah sapientia*), but traces of its influence are few.

L's *Ars* is the first symbolic logic. To each of the nine letters B-K one primary and five secondary values are assigned: By means of the four *figurae* (three are shown in Plates XXIX and XXX) the letters are combined in all possible ways: The values are substituted: The resulting conceptual complexes are expressed either as definitions or as syllogisms: The self-contradictory (which in practice include all inconsistent with L's beliefs) are rejected: The body of knowledge thus reached is accepted as exhausting the knowable.

The chief Aristotelian contribution is the assumption of necessary conjunction and disjunction of concepts (*καθ' αὑτό*) as the constructive principle of the system. The influence of Kabbalah is seen: In the borrowing of the name (in L's first work, LOK, only): In the nine primary principles—they are constituents of the Essence of God, but are not rational elements (Platonic) nor the principles of rival systems (Hermetic, Valentinian), but as in Kabbalah are arbitrarily chosen from among the conventional attributes of God, four being identical with four of the *Sephiroth*: *Bonitas* = *Hesed* (?), *Potestas* = *Geburah*, *Sapientia* = *Hokhmah*, *Gloria* = *Hod*. But Kabbalah is emanatistic, pantheistic, the universe being composed of enfeebled effluxes from the divine substance. This [view] L evades by interposing between God and the universe an act of creation; each attribute creates *ex nihilo* its like, an *essentia* in which the corresponding attributes of things inhere; LOAF 969: *quando Deus creavit mundum dignitates eius posuerunt suas similitudines in mundo.*

Yet L's language often suggests the emanation doctrine; e.g., LOR 201: (*Deus*) *est .. minimus, etenim omnium rerum essentias penetrat: quo autem res est minor et subtilior, magis videtur posse penetrare*; and often in LOPP. Moreover, Bacon here attributes to him Platonic doctrines (e.g., emanation, 762–772.; preexistence of intellect, 813–829) which he expressly repudiates. These are probably early beliefs modified into conformity with orthodoxy.

L connects letters with concepts, as does Kabbalah, but with different implication. They are symbols which facilitate logical operations; LOK 45: *Alphabetum ponitur in hac doctrina primo ut per ipsum figuras valeamus construere et principia cum regulis suis combinare facillime possimus, ut cuiuslibet rei intelligibilis veritas intellectui humano facillime uniatur. Qui intellectus per eas se longe generalem cognoscit, quod est namque per unam litteram huius alphabeti scibilia multa comprehendit de quibus scientiam facit;* but [they] are not identified with the attributes. But that such occult identification would not have been alien to L's mind may be inferred from LR 202: *Com Deus haja pausada virtud en paraules, pedres, é en herbes, quant mes donchs en los seus noms.*

The letter A is not used in practice because it signifies the totality of the nine attributes, each being identified with all; i.e., the *essentia*, *unitas*, *perfectio* of God. It corresponds with the first *Sephirah*, *Kether* or *Corona*, "wreath, circlet," in which all are unified. So LOK 91: *In figura prima spherica quae A intitulatur quaeritur primo utrum in ordine naturae sit aliquid unum in cuius esse subiectum et praedicatum convertantur essentialiter et identitative, cui respondendum est affirmative.*

Of the secondary concepts used by L there are five groups of nine each (Relations, Categories, Subjects, Virtues, Vices).

Plate XXIX
Lull's Figures I and II: from an old edition

[NOTES TO THE PRECEDING TEXT:]

30–35 *mixta*: L's technical term for concepts derived by composition of his elements; here applied to the principles of other systems, virtually all of which he regards as composite.

45–49 *lumen*: LR 482:

Enteniment es lum qui pren
Aquela causa qu' hom enten:
E está lum esperital
Que vál molt mays qu' el corporal.

50–56 *duplex*: LOPP 146: *Dixit intellectus: duobus modis intelligo et facio scientiam; primo per sensum et per imaginationem de rebus inferioribus tanquam in artibus liberalibus et mechanicis et de moralibus, alium modum habeo per ea quae sunt superiora, ut puta per Deum et per suas dignitates et per substantias separatas* . . .

153–60 *decentia*: for *propria*, probably because easily written by *coniunctio*. But the abbreviation read as *coniunctio* is indistinct, it might be *quaestio*. Of this [latter] I could make no sense.

161–82: The recomposition is arbitrary, but I cannot improve upon it.

183–253: Probably introduced to show the simplest way of permuting the alphabet.

258–346: These *receptacula* L calls *camerae*. Only 7 of the 84 columns are given in LOK (Pl. XXX, Fig. 9), but all are written out LOAM 260–66.

405–12: Note that the Greek word is obvious.

543–53: *ecstaticos:* "victims of hallucination."

597–616: L's view of the relation of reason to sense and imagination is essentially that of Aristotle. Sense supplies material to imagination, the latter to reason which makes it "intelligible," LQS 63v: *et sic est facta scientia de rebus sensibilibus. Et a simili de rebus intellectualibus intellectivo se denudante de speciebus inferioribus ascendendo ad similitudines angelorum et animarum et divinarum rationum sive attributorum.* The aim of the *Ars generalis* is the elimination of the sense-element, LOK 45 (already quoted), and 44 *Finis vero quaesitus in hac scientia est intellectus humani adeptio, sed medium ad ipsum finem est mera abstractio* . . . *quoniam cum intellectus humanus sit substantia abstracta oportet ut suum intellectum sit abstractum et consequenter suum intelligere.*

631–41: Cf. 921 ff.

642–86: LOAM 431: *anima vere rerum essentias attingit intelligendo, amando et recolendo.*

689–783: LOK 44: *esse sive verbum sub ratione inseparabilitatis a rebus est subiectum adaequatum huius sapientiae Kabbalisticae.*

739–52 *reperiantur*: LR 391:

E si 'ls termens no 't son donats
En las divinas dignitats,
De 'ls quels está la questió,
Sapias virar la sermo
A las divinas dignitats
Hon los termens son emplegats;
E ab ellas pòts concluir
Segons que es lur diffinir;
Lo qual diffinir fé ligar
Ab affermar ó ab negar.

762–72 *elementario*: taken literally, [this word] implies emanation.

802–06 *cupam*: note how obvious this rare and unexpected word is made on its first occurrence. The idea must be derived from Plato, *Gorg.* 493 A–B: *τῆς δὲ ψυχῆς τοῦτο ἐν ᾧ αἱ ἐπιθυμίαι εἰσὶ ... ἄρα τις μυθολογῶν κομψὸς ἀνὴρ ὠνόμασε πίθον ... τὸ ἀκόλαστον καὶ οὐ στεγανόν, ὡς τετρημένος εἴη πίθος, διὰ τὴν ἀπληστίαν ἀπεικάσας,* but I have not traced the channel by which it reached L. The transformation of *πίθος* into *cupa* suggests intermediaries.

This passage supplied the first clue to the significance of the cylindrical objects frequently occurring in the Voynich Manuscript. In every occurrence (save one?) the supposition that they represent either the material body or the animal soul makes the drawing intelligible; e.g., the *cupae* in which the spirits in *Pisces* (Plate IV) are ensconced may be the animal souls which spirits don before birth and doff after death in the "second death" (Plut. *de Facie* 942–3; *Poemandres*, I, §24; Clem. Alex. *Excerpt. ex Theod.* 27). But this is incompatible with L's later view that the sensitive soul suffers corruption (not annihilation) at the death of the body, but is reconstituted at the resurrection: LQS 49v.

813–29: The implication that the spirit preexisted as part of God is incompatible with L's [usual] doctrine of creation and more akin to Bacon's view of the active reason, *Op. Tert.* 74: *est Deus principaliter, et secundario angeli, qui illuminant nos.* Note the obviousness of the unusual *a sinu.* [But see page 147.]

830–33: A Lullian idea, LOPP 135: *Dixit vegetativa, sum virtus contracta in vegetato, cuius sum anima ... mea principia innata sunt bonitas, magnitudo, duratio ... in me contracta et specificata.*

859–920: *Natum* implies the emanation of *ens materiale* from God. The same argument, with that idea eliminated, is urged LD 121: *Et quia dicis secundum naturam corpus resuscitari non potest, verum dicis secundum naturam illius corporis sed non dicis verum secundum naturam divinarum rationum, quam habent in earum concordantia et in essendo aequales causae earum causatis, sicut divina bonitas quae est causa bonitatis causatae* (and so of others) ... 122 *sed hoc esse non posset, si non esset resurrectio et alia vita ... principium et finis nostrae vitae se invicem respiciunt et sibi invicem correspondent .. unde .. colligitur finis corporis hominis ita in fine per resurrectionem.*

921–84: LOOE 233: *Accidentia nunc libet appellare omnia quae extra Deum sunt et quae Deus non sunt. Solus autem Deus id quodquid est ... solus Deus est. Quae ergo non sunt Deus haud inepte .. accidentia dicamus. Sed bonitas creata est illius increatae velut umbra quaedam.*

985–1003: This is Bacon's view, *Op. Maj.* I 149: *puncta .. non sunt quanta.* L's definition, LOK 89, is ambiguous: *ens cuius esse est indivisibile et est principium lineae.* But later, LOAM 529–30, it is *minor pars corporis* and the line is composed of points, which would make it *quantum.*

1004–60: *Phalanges* is the term used by Bacon in the text underlying the Key [Chapter IX], for the biliteral symbols. Here it probably means the letter-groups, as does also *vocum:* "The letter-groups should be used in order that Being may be indicated for the benefit of sense-perception by the sense-content of these auditory and visual symbols."

LR 393: *E mant ver á ta voluntat*
Si segueix lo significat

plentiam in intellectu humano. Quare, &c. Et notandum est insuper quod hæc figura deseruit operationi secundum intellectus, cuius proprium est componere, & diuidere. Exemplum primi, omne bonũ est Iustum. Exemplum secũdi nullum bonũ est auarum, & hæc sufficiant de tertia figura.

QVARTA FIGVRA.

DE FIGVRA QVARTA SERMO.

CAPVT. V.

QVARTA figura componitur ex tribus circulis, quorum maior immobilis est reliqui...

TABVLA GENERALIS

.I.	.II.	III.	.IV.	.V.	.VI.	.VII.
CDT	CDET	DEFT	EFGT	FGHT	GHIT	HIKT
CTB	CDTC	DETD	EFTE	FGTF	GHTG	HITH
CTC	CDTD	DETE	EFTF	FGTG	GHTH	HITI
CTD	CDTE	DETF	EFTG	FGTH	GHTI	HITK
DTB	CETC	DFTD	EGTE	FHTF	GITG	HKTH
DTC	CETD	DFTE	EGTF	FHTG	GITH	HKTI
DTD	CETE	DFTF	EGTG	FHTH	GITI	HKTK
TBC	CTCD	DTDE	ETEF	FTFG	GTGH	HTBI
TBD	CTCE	DTDF	ETEG	FTFH	GTGI	HTHK
TCD	CTDE	DTEF	ETFG	FTGH	GTHI	HTIK
CDTB	DETC	EFTD	FGTE	GHTF	HITG	IKTH
CDTC	DETD	EFTE	FGTF	GHTG	HITH	IKTI
CDTD	DETE	EFTF	FGTG	GHTH	HITI	IKTK
CTBC	DTCD	ETDE	FTEF	GTFG	HTGH	ITHI
CTBD	DTCE	ETDF	FTEG	GTFH	HTGI	ITHK
CTCD	DTDE	ETEF	FTFG	GTGH	HTHI	ITIK
DTBC	ETCD	FTDE	GTEF	HTFG	ITGH	KTHI
DTBD	ETCE	FTDF	GTEG	HTFH	ITGI	KTHK
DTCD	ETDE	FTEF	GTFG	HTGH	ITHI	KTIK
TBCD	TCDE	TDEF	TEFG	TFGH	TGHI	THIK

DE ORDINE TABVLAE.

CAP. IX.

ORDO quidem columnarum tabulæ consistit in positione litteræ. T. namque vel ista littera consequitur ad B. C. D. Aut præcedit, aut interponitur, vt in ipsis columnis

Plate XXX

Lull's Figures IV and IX: from an old edition

The circles of IV were still movable on the thread which fastened them, as a pivot, when Newbold saw them

De las lletras, en qui estada
Tanta veritat plegada,
Que tota hom no pòt sauber
En esta vida, ni veer.

1061–1183: L teaches that the cooperation of the celestial bodies is necessary to the generation of life (LQS 29r *homo non posset filium generare neque planta plantam in absentia influentiae corporum coelestium*), but does not explain the process in detail. Cf. LR 512:

Car hom en quant es corporal,
Participa ab celestial,
Ab elements, é vejetat,
Ab sentiment, imaginat,
E en quant está de raysó
Ab l'esperital.

1084–1173: L uses a similar metaphor, LQS 37r, concluding: *supposito quod mensura vini esset posita in dolio aquae et quod in sua specie remaneret et quod augmentationem ab aqua reciperet* etc. The *cupa* must be the animal soul (for, obviously, repentence does not tend to cause physical death). Cf. IQS 50r: *quando anima creatur et infunditur in corpore hominis ipsa venit munda et pura et cum sua connaturali libero arbitrio ... mutata est et infecta* (50v) *a carne ... et infectio carnis est a primis parentibus.* This infection consists in a perversion of intellect, LQS 29r: *sequitur quod quicquid intellectus in suo proprio intelligibili deducat de intelligibili remoto sit perversum in ipso intelligibili, hoc est recipit characterem in contrarium, sicut sapor pomi quod est dulce in gustabili infirmo.* In consequence *ligatus est*, but if he repent, *tunc venit gratia Dei et homo curatus est ... exit a carcere.* Physical death is due to the corrupt condition of the body, and in speaking of it L uses the same metaphor used by Bacon; LD 179: the soul goes out *sicut fracta amphora ab ipsa vinum recedit.* But the distinction between the animal soul and the material body must not be emphasized. L does not use the terms himself, and the analogous distinctions which he does recognize are treated more in the spirit of monistic idealism than of dualism.

1253–59: L's visions must have exposed him to the charge of insanity, and the title of one of his works, *Disputatio Petri clerici et Raymundi phantastici*, also suggests it. In 1275, at the petition of his wife Blanca, the Court at Palma put a trustee in charge of his estate because *est in tantum factus contemplativus quod circa administrationem bonorum suorum temporalium non intendit et sic eius bona pereunt et etiam devastantur* (LR praef. 34 n.).

[Vatican Manuscript, Lat. 3102, folio 27 v, paragraph 2:]

```
16  p  r  i  m  a  e     q  u  a  e  s  t  i  o  n  i     d  i  c-
       C  N  Om Ml Ml       T  E  ml I  Cp pt Ai o  e        t  I
                                                  COMMENTICIAS        12

20          -c  i  t     q  u  o-
  Ml pt O E T :  u  Oic     D  S                  METhODOS            19
```

33 -o d *aa be ce de* t a m e n n o n e s t
Pt Oic : Al S S u S a Lm e E s o i Cp
ECSPLOSAS 28

34 n e-
u A e s U I : A A VIA 32

44 -e c c e s s a r i u m
u E S : i Iu U i u N G N Ec S SEIUNGENS 41

56 n i s i s i t c n l m c t l i-
O i I U : E I L L Icu T cp C e N G N
ILLE CONIUNGIT 54

71 -i *e c s p u n c t o* r f a c t a i n
i Cp e : i I r p C Scp e N Pa u Uicm i n A T
ICS PUNCTA 63

71
i e I R F E u I N : INFERI 69

80 b c z n d r s e c u n-
i e u : I R Cp Le U Al I D C CIRCULI AD 78

92 -n d a e q u o d *aa* p r o y d m l-
i E U : El T ml t S Al *S* Q se t Icu N
SEQUENTIA 87

97 -l n d g c z z-
i Lm t Se T : pc El I L O ET ILLOS 94

102 -z l *ce* v e r o
I T Pc : o U Mp i Se SUMPSIT 101

109 p r o g c z z l n-
O i : C Se I R U u Cp CIRCULOS 109

119 -n c t e r t i a e d i c i-
i U : e Am Y Si Bt Ml Lm T i O
UT SYMBOLA 118

125 -i t q u o d *ce* q u-
I E i : Uic T S Al S T UTENS ISTA 127

138 -u a r t a e *ge* q u i n t a e q u-
I : E C *S*i A Lm Lm T A T s a lm D
CALLIDITATE 138

141 -u o d *de*
S A Rm : S Al U *UT* ARS SUA 146

154 s e c s t a e q u o d *ee* s e p t-
: Al *I* *L* Pc A Rm T S Al s Al icl B
SEPARATA AB 156

164 -t i m a e q u o d *ef* o c t-
s Icl : tp Oml Ml Ml t s al e C N
COMMUNI 163

173 -t a v a e q u a n d o
S T t S Al E : a T E Rm *T* E Sml *El* Ie
ARTE ESSET. SI 174

184 i n *p a r a g r a p h u s*
t A : t R c N ml Cm n I e I P PRINCIPIA 183

186 r e p-
D t C Rm N E : El Icl DECERNIS 191

192 -p o n i t u r
T : C U E Icu *U* *S* ET CUI 196

205 u t d i c i t q u a r t a q u a e-
: Se T I U Icu T e c Is A t e Lm
SINT UTILIA 206

215 -e s t i o c *r i* b r *r i*
E c D e : *I* *Pc* tp ia r *N* ml i S n SED 209

215
C E Dp Ia R ml i n CREDIS 215

225 s p i n o s a e s t l s n-
Rm I N : P Al t *S* *Uc* n I Pc oa C
PRINCIPIA 224

232 -n l p d *t i* s y
t N Oa : Cp Gp N I Tp I Al INCOGNITA 233

245 c o m m u n e u t d i c i t q u i-
t : N Nla S S C A Es T *I* O Ui t A
NON CAUSAS ET 244

253 -i n t a q u a e s t-
t t : T S A D E Ml I Cp MICSTA DE 252

259 -t i o e t n o n a l-
t T : Ft Ia Il S u Ca FICTIS 258

273 -l i t e r c o n s e r v a t u r
t U : N Uic ma I N O N Ra I S E e o S
NON UNIVERSIS, 270

276 q u a n-
t Ma E O : T E Mls MEMENTO 277

285 -n d o e s t u t d i c i t
D : Re Ei i cp se t i U Icu
VIDERE 283

291 s e p t i m a
I cp Se t i : Ra Cil P Tp Um Ml SCRIPTUM 291

305 q u a e s t i o d e c i m a e d i-
cp D I : D E ml i cp pt Ai U i u Uml ml ml T
"DE AUDITU 299

314 -i c i t q u o d t q s t
Kp Lm I Bc Bt i O ml ml : I u uic T S Al A l Cp
KABBALISTICO" 311

314
I Lm Lm u Uic L : LULLI 316

327 f i t e c s *a s t e r i s c u s*
U : D Icu i L cm cp am I N I A T B
UBI DELINIAT 327

335 g z t l d l c u m *s p-*
I cm cp am : Cm ni c T O t S P
PICTOS 333

343 *-p i c u l u m* z l y-
cm cp Am Ni G T : Ra I t s O S U L
TRIANGULOS 343

347 -y t l z z-
Mc Bc T S : Ia C Uc U CUM TRIBUS 352

360 -z c t r p e r c z z d m b l *b e-*
: Ae N Us pea i R O T Uicm *E* I L S
ROTULIS. UNA 362

375 *-e t b* s m u n d e c i m a e e t d u o-
Bea I : Li n O ne cs e u I u Mlu Ml ml Il ei S
IMMOBILIS, 371

388 -o d e c i m a e d i c i t q u o-
n ne cs El O u Lm Ei : Al U I u Mlu ml ml D i u icu t S
DUAE MOBILES 382

388
N Ne Cs O U Ml Ml I u Icu t IN COMMUNI. 391

395 -o d i n f r a q u i-
u T : *Ra* D *N*la Ia *N* D A ADDIT 396

408 -i n t o *l a* l d y s i b e n e r e c-
u : T S Pa en Ac t u l s *E* A el I
SPATIA 402

413 -c s e r i t
u En T u L S el : R al I n Icu LITERIS 409

425 s i m a l e p r o p o r t i o-
u u El al N : l Ml Ac R G es Np c u Is tp Ia
IN MARGINE 418

427 -o n a-
u u Al l es Q U tp : o Sml QUAS 422

437 -a l i t e r t q s t y d-
u u R Es Pt O : Ac N icu am i a l cp e T
REPONAT 429

439 -d *l i*-
u u Icu Ma I A R Cp E : u N IN CAMERI*S* 438

446 -*i* d n l y y d e q u-
U O U : e Ia cp L s u T VOLVIT 444

451 -u i n t a p r-
e Pc S u : A t s A C SPAC*I*A 450

461 -r i u s l o c u t i f u i-
E U T s : Ne Ce p Ce c T s T O A
UT CONNECTAT 461

475 -i m u s f i t e c s *a s t e r i s c-*
S P C S : Mlu S P t Uic I r Cm cp Am I *N* I A
SPACIUM SPACIIS 475

484 *-c u s* e t *s p i c u l u-*
T R Cp : t p Il P La I D *S* U
DUPLICITE*R*. 485

492 *-u m* e t v o c a t u r
t p : S Il C C U E O S SIC VOCES 493

502 *s o l - o c c i d e n s*
T p : Ni Ap Ec c Iu u *E* U E N INVENTAE 501

507 u l t i m a-
p C U : S Np Tp Uml Ml SUNT CUM 508

521 -a t u s i n q u o *m u c i n e s r a*
p : E u p t T S S E u t a I S N
ESSENTI*IS* 517

526 c o n s e r-
p u p t u t a : N O N al *I* NON 520

533 -r u a t u r e t e c-
P U P T O t a la : S e e u S Il I
SUPPOSITI*S* 530

544 -c s c i t a r i d e b e t
t a Ra e E O : L a U Uic a C N U S S Il
VOLUCRI SENSU. 542

554 p e r *s o l - o r i e n s*
t a E A a : Pea I in Ap Ec u N i E N
EAE PINNAE 551

561 *b e t b c l i* b-
t a A In u I : S il n u r N Ml ANIMIS 557

565 -b r n s m
T a U Il N U R : I s N Ne INV*E*NI*U*NTUR. 568

578 c u m *b e t b* l n d *t i* l b s-
A S : t s S Il N ei C el i Tp Cm R Ei
SI CRESCANT 578

586 -s y l s n l p d *l i*-
T s Ei El i : ra Np C Cp P N O N NON PECCENT, 588

593 -*i* l a d e o c o o p-
S I ra : cm a o r N O Np SI NON, 593

605 -p e r t u m q u o d n e q u e
Ra Cm a O R : Pea i Is U S t s ra a i t Bm
CORP*O*RIBUS 603

610 f r i g i d-
A I T S Ra a i t : ai N s s E SER*V*IANT 611

620 -d u m n e q u e c a l i d-
a I T ai S S : Ei S a i t Bm U ac N E
ET SENSIBUS 621

628 -d u m s e d q u a s i
A Ai a i t ac : Ei s Ra T T E cm R
ET A TERRA 629

639 m o r t u u m c o n s e r-
a I T Ac S Cm : E u Is *U U S* N O N L *I*
NON ECSILIA*N*T 641

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645  -r v e t    d e c e-
  a O :  Cp Pm il      U i U                  VOCUM          646

656     -e m    s o l - o r i e n s    e c s-
  a il i :  T       In ap ec U N I E N       I L
                                             ILLINIENTUR    657

665          -s p l i c i t    p r o    n u-
  a il i Ap E :  p  Pc N i U Icu     c s      N
                                             PINNAE         663

678              -u n c  D E O  g r a t i a s  a m e n
  a Il i P I C Se :  c E     o l    Mc N E D Rm cm    Lm e E
                                             E PICSIDE      671

678
  A I G O L Cm E                             LOGICAE.       678
```

[The division of this text into lines is as follows:]

Line	begins	ends	Line	begins	ends
1	Pri- 1	-ml- 92	5	*-be-* 359	-nta 450
2	-nd 93	in 174	6	pri- 451	-bet 544
3	*par-* 175	-tur 273	7	per 545	-tu- 632
4	qua- 274	-bl- 358	8	-um 633	amen 678

[The following letters come in the recomposed text (TR) before they are found in the transliterated text (TD):]

S 12 - 87	N 199 - 391	I 516 - 639
S 99 - 128	S 215 - 219	S 530 - 634
L 107 - 144	I 223 - 241	E 561 - 677
N 122 - 211	N 275 - 393	U 564 - 632
I 134 - 143	E 283 - 357	O 598 - 633
U 139 - 220	E 321 - 405	V 607 - 661
T 140 - 169	R 348 - 389	N 640 - 659
E 148 - 172	B 378 - 641	M 646 - 670
U 161 - 191	S 438 - 483	L 649 - 676
P 181 - 207	I 449 - 526	R 657 - 674
I 182 - 206	N 456 - 473	
S 191 - 192	E 484 - 499	

[Notes to the text:]

35: *neccessarium*—so in Ms.

42–87: Plate XXIX, Figs. 1 and 2. L conceived the smaller circle as the lower; LOK 56: *et sic de aliis literis alphabeti circuli minoris mutando ipsas litteras a B circuli immobilis usquequo pervenerit ad I circuli mediocris et ad K circuli inferioris.*

184–91: *discernis* would seem better.

292–316: Subtracting the letters of the title of L's first work leaves as remainder his name, which would not be true of any other of his hundreds of works.

328–59: Plate XXIX, Fig. 2, and XXX, Fig. 9. LOK 52 says that the triangles are colored red, green, and yellow.

360–91: The two smaller "wheels" are on separate slips, attached by a thread through their centers.

432–38: Plate XXX, Fig. 9; cf. note to preceding text, 258 ff. (p. 165).

543–68: cf. LR 392: *Per la taula porás trobar*
Con sapias de Deu parlar....
Ab ço qui t'es significat
Per cada lletra, et monstrat
Segons qu'es son alfabet;
Perque no pòts esser constret
Per defalliment de raysons,
Car la taula ha tants d'escalons
En pujar alt ton consirar,
Que mays que no porás parlar
De Deu están li escaló.

569–88: Cf. Plato, *Phaed.* 248–51.

622–41: Note that the reading is confirmed by the title of the first paragraph.

642–78: Cf. Apuleius, *Metam.* III 21: *Pamphile .. arcula quadam reclusa, pyxides plusculas inde depromit, de quis unius operculo remoto atque indidem egesta unguedine .. sese totam .. perlinit .. promicant molles plumulae, crescunt et fortes pinnulae ... fit bubo Pamphile.*

[Vatican Manuscript, Lat. 3102, folio 27v, first paragraph:]

The first paragraph of folio 27v expresses, in different wording, the ideas of Averroes' preface to the Categories. Its occurrence between two paragraphs of obvious cipher suggests the suspicion that it also may be in cipher, the paraphrase of Averroes being another of Bacon's numerous modes of camouflage. This suspicion is strengthened by the facility with which the opening words recompose, a peculiarity not shared by the printed text of Averroes (Venice, 1574). Further study of this paragraph, in which the cooperation of others would be welcomed, is for the present deferred.

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13 C o m m e n t a t i o n e s
     n Nla S E e S A e Tp Ia U a I      SENSITIVA          9

28       A v e r r o i s   s u p r a   l i b r u-
  N E e a : S Mp I u se e I     C in c n      n Lm I S
                                          NEC SIMILIS        19

35                -u m   p r a e d i c-
  E A U Se E In G N n : S      o n ml T T I
                                          EST SIGNATIVAE     32
```

38 -c a m e-
N C n ml : u ml E NEC 35

42 -e n t o r-
N Rm U Ml : E s pa O NUMERO 41

50 -r u m o s t e n d i-
s pa : s S uc pc Am e El T EST 44

56 -i t u r i n t e-
S Pa S Uc Pc e : Icu O s T s Am SUPPOSITA 53

57 -e n-
E S S : E ESSE 57

67 -n t i o i n h o c s e r m o-
: s Dp Ia T I Cp Al i Nspt E
IDENTICA. 65

CHAPTER XVII

The Paris Medical Text

The late Professor Pierre Duhem of Bordeaux[1] discovered and in 1909 published[2] a previously unknown letter of Bacon to Pope Clement IV, in which he says, "A third document (*or* work) I have sent from my hand by John, that it may be transcribed for your Glory. And there, though it is in manifold concealment (*occultatio multiplex*), yet it is not by enigmatic words, for these I explain to a considerable extent, but it is by a method more philosophical and scientific. For since Natural Philosophy, Medicine, and Alchemy have their roots in common, I have therefore pretended (*simulavi*) that I was teaching (*tradere*) these roots as though they were merely natural and medicinal, and as such I have introduced them."

With my knowledge of the nature of Bacon's cipher, I saw at once what these enigmatical words meant. The "scientific" method of concealment is cipher; this is the reason that it must be transcribed for the Pope. He has "pretended" to write on medicine; i.e., the upper text is on medicine, the under, cipher text, on alchemy. I recalled an unpublished medical text of which I had a photograph, discovered by Mr. Steele[3] in the Bibliothèque Nationale of Paris, and identified by him as a work of Bacon. I had read the first few chapters and had found it difficult to believe that Bacon could have written such confused and clumsy Latin, for his natural style

[1] [The materials for this chapter are a part of the letter of December 14, 1923, to Provost Penniman; a transcript of the deciphered text; and a few miscellaneous memoranda.—RGK]

[2] [See Chapter IV, Note 21.—RGK]

[3] [Robert Steele, Esq., Savage Club, Adelphi Terrace, London; editor of a series of previously unpublished works of Roger Bacon, published by the Clarendon Press. The manuscript in question is Bibl. Nat. Paris 6978, f. 27v.; it purports to be a form of the *De Accidentibus Senectutis*, sent to Innocent IV (1243–54); cf. Little, *Roger Bacon Essays*, 4. The opening words of the text used by Newbold in his interpretation are the following: *Incipit epistola de accidentibus senectutis missa ad Innocentium quartum quondam summum pontificem.* This should be sufficient to identify the passage in the text as edited by Mr. Steele, in a volume of the *Opera Inedita* soon to be issued from the press.—RGK]

is exceptionally clear. But if it were cipher-Latin all would be explained.

I applied the alphabet to it and found that it read off very easily. This, however, does not prove it to be in cipher: for that one needs a series of unknown but verifiable facts. The small portion of the text which I have read yielded a series quite sufficient to demonstrate that the text is cipher. The more interesting are the following:

It appears from the text (1) that the Pope is suffering from stone in the bladder, and has asked Bacon for medical advice. Bacon prescribes both medical and surgical treatment. The medical treatment comprises the following points:

(2) By means of a catheter, wash out the bladder with hot water; this will relieve the pain. This of course I knew to be in use to-day.

(3) Keep the washings for eight days in tin receptacles, putting in tincture of camphor. I knew that camphor, as a disinfectant, would retard putrefaction.

(4) Dissolve in them "dregs of saltpeter;" the density of the urine can then be estimated from the amount of sediment deposited. The meaning of this step was entirely unknown to me. Upon inquiry, I found that the urates are soluble in acid urine only; the saltpeter is an alkali and will cause the deposit of the urates held in solution.

The surgical treatment:

(5) Make an incision along the urethra; introduce a *lingula* (spoon?); gently remove the calculi. I knew in a general way of this operation.

(6) Wash out the wound and the bladder with a "tincture distilled from charred tow (*extinctis stupis*) which had been lighted on the fourth day of the moon." When I had deciphered this I saw its meaning. The tow must be lighted when the moon is waxing, an astrological principle generally observed for all medical and surgical treatment in Bacon's day. When charred it must be put out; the "tincture" made from it will then contain *creosote*, which is not only a powerful disinfectant, but also an analgesic. I have since been told that it is still used in bladder affections. But I am quite sure that I could not have thought out for myself this method of obtaining creosote.

(7) Pack the wound with *sphagnus*. I did not know the meaning of this word; upon looking it up, I found that it was a fine moss. I have since learned that it was used to some extent during the late war.

The remainder of Bacon's surgical instructions contained nothing susceptible of verification.

(1) The fact that Pope Clement suffered from stone in the bladder I have not been able to prove, but I have found evidence tending to confirm it. The Pope's letter to Bacon, as printed, is dated June 22, 1266. In a letter written seventeen days earlier,[4] the Pope says that he has showed John de Procida his feet and shins, but refused to take the medicine which he prescribed. This suggests the kind of dropsy seen in heart and kidney disease. The Pope died November 30 (or 19), 1268. The only reference to his symptoms is in the Auct. Vindebon.[5]: "His tongue, in his agony, smoked out of his mouth." This determines his disease as nephritis, which is often associated with stone in the bladder. Dr. Thomas Klein[6] writes me, "In cases of stone in the bladder we frequently have an associated nephritis. One of the ways of death in nephritis is uremia. In uremia the tongue becomes very dry and beefy red in color, and is frequently covered with dry brownish secretions. With the above characteristics you usually have added a distinct furrowing, which would give the impression that the tongue was being burned up."

The medical and surgical advice concluded, Bacon turns to the alchemical. Of this I read only a little, [but noted] (8) instructions for a chemical reaction by which metallic copper may be produced by heating together wine-lees, salt, and vitriol. [This I reserve for the next chapter, but note here that actual experiment proved the method to be correct and capable of producing the result.]

Of these eight [verifiable] points, [therefore, which I read in the decipherment of the Paris Medical Text,] seven are completely and one partially verified. Three of the eight, Nos. 2, 3, 5, were known to me [already]; five, Nos. 1, 4, 6, 7, 8, were not.

[The deciphered text of this Paris Medical Text is as follows:[7]]

Theoriae ab experimentatoribus inveniuntur et ex successibus suis ad extremitates adiguntur. Ista experimenta extollunt ut

[4] June 5, 1266; see Martine, *Thes. Anecdotorum*, vol. II, col. 340.

[5] *Mon. Germ. Hist.* VI, *Script. Volg.* p. 648. [To find] the cause of Pope Clement's death necessitated a search through about two hundred folio volumes of Chronicles and the reading of about six hundred of the Pope's Latin letters.

[6] [Associate Professor of Medicine in the Graduate School of Medicine, University of Pennsylvania.]

[7] [In this text *cs* has been normalized to *x*.]

proxima fundamentis omnis scientiae. Parallela sunt, propterea nunquam sibi contradicunt nec pugnantes exsuperant invicem.

Cave dicentes *destinam* et voluptatem intractabiliores esse, quarum una non demet animae virtutem nec appetitum altera. Licet voces eam voluptatem nichilominus existit ad determinandum celeriter, necnon veraciter suum agendum et cuncta sequentia. Existit quasi sal existat ad efficiendum substantias expertes corruptionis. Simile efficit delectatio sensualis, ut spiritum associaret externalibus.

Sexto mensis Septembris, anno MCCLCSVI[8] neminem nisi me invocasti in altitudinem, me, paene in vinculis et semianimem audisti et a morte revocasti. Nisi perveniret vox tua, periclitarer in non ente suffocandi.

Dicis, urina urit, sensus pungentis quasi acus pungens illic esset. Mea studia citasti, me advocasti, nonne possim calculos mitigare, et ut aliquas medicinas consulem medicis.

His calor sufficit. Para siphonem quo immittas lotiones ad partes quascunque. Immitte ad partem dolentem; tunc minuetur dolor. Vesica non sit plena cum siphonem immittas, ne insinuans ipsum irrites eam ita ut expellat quicquid acceperit. Maneat in canale donec implet vesicam, tum detrahe lotionem ab vesica et impleas eam denuo. Immissas plene in stanneis detrahe receptaculis et adde tincturam subtiliter ex camphorae pulvere destillatam. Lotione impletis receptaculis, si attrectantur, misceantur stillicidia e stanni manantia poris in tincturam. Recipe ex receptaculis post octo dies lotiones, dissolve in eis salis petrae faeces. Ab liquido selige faeces et aquam illis immisce. Urinarum aestimentur spissitudines a sensibili excessu sedimentorum.

Sume cultros et seca in seminis meatu ad vesicam. Ut pervenis, insere lingulam. Divina ubi lingula se sistit copia sit calculorum. Non office eis; consistat; distringantur identidem calculi. Immisceat se lingula in calculis transferens eos ex vesica et incipiens extrahere eos ab vesica. Si sistunt se calculi trahe identidem ab vesica adstante capite lingulae. Extractis fragmentis via canalis inice tincturam ex extinctis destillatam stupis accensis ad quartum lunae. Impone sphagnum, cingatur arte. Quasi tertio notetur cicatrix, si colligentur extremitates. Fiat aculeolus de adamante; insue ilio culleum et in eo pisse quo liquosa manent illic.[9] Voveas

[8] = MCCLXVI.

[9] [Or perhaps rather] in eo pissa quo liquosa maneant illic.

munditati illa; excipiant excretam pituitam quae exiet[10] ex vulneribus. Ansam subice qua mingens utaris ut evacues eum. Posset sphagnus detrahi de capite vesicae; non attempta ducere istum lineari crini. Evacua fragmenta. Non licet sphagno occupare vesicam.

His principiis extructis, multis licet facere mirabiles curationes. Fundamento decet immutabilitas; decet accidenti perspicacitas.

Papa sancte, O mei non obliviscere, tuam non sperne clementiam esse, vi adiuta me ut succedat iusto, non paveat, eius non sis immemor calumniati. Existat usus suis novis successibus, nullus eum deterreat ab suis experimentis. Nono Ianuarii millesimo ducentesimo sexagesimo septimo annalia tua ostendent, temptavi tuas iras, cui nunc vires evocasti intempestivas; nunc illae nichil componant tibi alterum tractatum nisi illis hic participet cunctis.[11]

In mixtis elementa existunt mixta cunctis; si autem provenire possent e solutis elementa et decoctis, ut elementa accipiuntur.

Immisce faeces vini et sales viles vitrioli, exime excessum, evacua in vasum, ne igne accenso vapor vini incensus incendat vinum. Selige vasum ab igne, investiga si aes illic consummatur.[12] Inde dicatur elementum. Artis est alchemiae indicare quantitates. Salis saltem si sumentur tres unciae, faeces debent fuisse non minus XX mensuris. Si maius, non redeat ad aes. Sed vitriole faciet aes nichil obstante. Non debet minus esse aes quam unciae X. Non faciet aes concinnum novum nisi orichalcum sit in illa et nisi tres unciae praesto argenti vivi sint, ut e vitrioli uncia una cupri extracta esset. Vile aes inventum fuit in vitrioli, sed squamae—id est impuritates—vitriolis exeuntes e vile aeris massa coquent et purificabunt aes ex cunctis celeriter impuritatibus. Sextuplum inice ad squamas argenti vivi voluti in plastro. In aere vitriolis erit velut pila inusta superstes. In eo vivi argenti plastrum sive seriem plastrorum siste, sive illa segregans, pro puncto siste.

Sic erunt detecta elementa finita quibus species replices decompositas et disiunctas et summo tentamine purificatas et inalterabiles.

[10] [So in Newbold's manuscript.—RGK]

[11] [Here begins the alchemical portion.]

[12] [This is the formula for the production of metallic copper, which is discussed in the next chapter. Newbold wrote consistently *vitriolis* as a noun of the third declension, and doubtless had authority for this spelling, though the Editor finds only *vitreolus*.—RGK]

CHAPTER XVIII

The Formula for Producing Metallic Copper

[In the Paris Medical Text described in the last chapter, Bacon, as has already been said,] gives instructions for a chemical reaction[1] by which metallic copper may be produced. I took this [formula] to Professor Edgar Fahs Smith, [ex-Provost of the University of Pennsylvania and Professor Emeritus of Chemistry; he had at that time[2] recently retired from both administrative and teaching duties.] He said that he had never heard of the reaction, but thought that it would "work;" he referred me to Professor Hiram S. Lukens,[3] who was so kind as to try the experiment. It was successful.

Professor Lukens wrote me [two years later, on December twelfth, 1923, a letter which I quote here in full:]

"I have often wondered whether you have succeeded in uncovering any further receipts from the Bacon manuscripts other than the one you brought to my attention during the Christmas Recess in 1921.

"If you remember, at that time you asked me to repeat an experiment that you found described in the manuscript and which purported to be a receipt for making copper. My recollection is that directions were given for bringing together blue vitriol, common salt, and wine lees in definite proportions by weight and heating the mixture under rather carefully defined conditions in a retort. The result of these operations was alleged to produce metallic copper.

"The experiment was performed in your presence and metallic copper unquestionably resulted. I believe you carried away some of it with you, though the sample was a small one.[4]

[1] [This Chapter is arranged from the same sources as that on which the preceding is based, with the addition of certain documents specified in the text.—RGK]

[2] [December, 1921.]

[3] [Professor of Chemistry in the University of Pennsylvania.]

[4] [Newbold received and kept the retort in which the experiment was performed, still containing some of the product of the experiment. At a public meeting held

"The process suggested is entirely sound chemically, although I must confess that this particular method had never come to my attention before. In fact the process is such an unusual one that it is most unlikely that it would suggest itself to a modern student of chemistry. The very method proposed is indicative of the antiquity of the proposal.

"It would seem to me that further efforts to repeat other experiments that you find described should tend to prove that the documents were certainly authentic and their translation a most commendable achievement.

"I shall be only too glad to try and assist you further should you care to have me do so.

Sincerely yours,
(*signed*) Hiram S. Lukens"

[The essential part of the deciphered text is as follows:[5]]

> Immisce faeces vini et sales viles vitrioli.[6] Ecsime ecscessum. Evacua in vasum. Ne igne accenso vini incensus vapor incendat vinum. Selige vasum ab igne. Investiga si aes illic consummatur.

[That is, "Mix wine-lees and common salt(s) with vitriol. Take off the excess. Empty (the remainder) into a retort. Do not

---

to honor his memory, on December 1, 1926, this retort was presented to Provost Josiah Harmar Penniman, for preservation by the University. With it went the following signed statement:]

Philadelphia, December 1, 1926

This retort contains metallic copper, made according to a secret formula of Roger Bacon which Professor William Romaine Newbold read by the cipher which he had discovered. The formula was unknown to us and could not have been evolved by Professor Newbold's subconscious mind. The experiment was made and the result—metallic copper—is in this retort.

(signed) Edgar F. Smith
Hiram S. Lukens

[The retort and the statement are now accessible in the Library of the University of Pennsylvania.—RGK]

[5] [According to Newbold's notes, this begins with letter 2981 of the decipherment of the text, and extends to 3135.—RGK]

[6] [Dative of *vitriolis*; see last note of the preceding Chapter.—RGK]

let the vapor of the wine take fire when the fire has been lighted, and (thus) set the wine on fire. Remove the retort from the fire. Examine to see if copper is produced there."

The formula goes on to specify the relative amounts of the components of the mixture: if three ounces of salt are used, then there should be employed not less than twenty of wine-lees; but if more are used, the process will not result in producing copper. It then prescribes the separation of the copper from the impurities by means of *argentum vivum*, "quick" silver or mercury.[7]

Professor Lukens still retains a vivid recollection of the details of the experiment. He recently[8] went over the formula and described the procedure followed in 1921. The term *vitriol*, he explained, is used in four meanings: (1) sulphuric acid; (2) copper sulphate, often specified as blue vitriol; (3) iron sulphate, called green vitriol; (4) zinc sulphate, called white vitriol. The use of the term in the last two meanings had not yet developed in the time of Roger Bacon; but the first two meanings had come into use almost simultaneously, and before his time. Naturally, if copper were to be sought, the *vitriol* to be used must be copper sulphate and not sulphuric acid; for some one of the components of the mixture must contain copper in some form, at the outset, or none could be produced.

Accordingly, he took wine lees, sodium chloride (or common salt), and copper sulphate, and dissolved them in water. A precipitate was formed, and the excess water was drained off. The precipitate was emptied into a retort, and heated over a flame. It gave off an inflammable vapor, which, according to the directions in the formula, was conducted away to a safe distance from the flame under the retort, before being allowed to disperse in the air; thus, as the vapor was kept from being ignited, there was no flame which could strike back into the retort and set fire to the mixture itself.

When the process seemed to be completed, he took the residue which was in the retort and poured mercury upon it, and thus digested it at a low temperature for about an hour. He then poured out the mercury and distilled it, and found that there were

[7] [Ending at letter 3656 of the decipherment.—RGK]

[8] [July 15, 1927.]

little crystals of copper left as a residue, which established the validity of the process and the accuracy of the formula read by means of the cipher.

The following is the Latin text from which the important part of the formula is deciphered:]

> . . . consueverunt senectus et senium et eorum accidentia proveniunt ecs debilitate caloris naturalis et debilitas caloris provenit ecs dissolutione naturalis humiditatis et ecs augmento ecstraneae et mihi cordi est. . . .

[The detail of the interpretation is as follows, according to the usual method. At the beginning, there are the values of four symbols, C S E I, left over from the preceding text; the values of the first three symbols in the Latin here given go with the preceding text, as does also the value of one later symbol, italicized and placed in parentheses. All the letters of the interpretation are found in the Latin text here given, except the four which are carried forward from the preceding. The values of seven symbols pass over to the next sentence after the end of this part of the chemical formula.]

c o n s u e v e r u n-		
c s E i : (*N U U*) cp Mp Ic Mp I S C	IMMISCE	7
-n t s e n e c t u s		
c S i Cp : s Ar E a i n u P	FAEC*E*S	13
c I s a I N U	VINI	17
e t s e n i u m		
c S A : ir Ra E e Ec S	E*T* SALES	24
e t e o r u-		
c ir E : Ir R U S	VILES	29
-u m a c c i d e n t i a		
c Ir : s I Iu U (*E*) U *E* s Tp Rm	VITRIOLI	37
p r o v e n i-		
C S s : c es n Mp E E	ECS*IM*E	43
-i u n t e c s d e b i-		
S C Es n : Ec C S i *R* U S Mr	ECSCESSUM	52
-i l i t a t e c a-		
N I : Cm n Uic A E Am U	EVACUA IN	60

-a l o r i s n a t u r-
n : Ac ce U n i Mrs e U S VASUM 65

-r a l-
N Ec n I E : N Ca NE IGNE 71

-l i s e t d e b i l i t a s
N : n i ir U S mr Cm n icu A Cm ACCENSO 78

N I Ir rm n Uic VINI 82

c a l o r i s n a t u r-
rm N : u ca Ce u N I Smr E U S INCENSUS 90

-r a l i s p r o v e-
Rm U Ac U : n ca n i c es n Pm VAPOR 95

-e n i t e c s d i-
N Ca n I c es N : E e icu i r T INCEND*AT* 103

-i s s-
N c es e Uic I r : i U VINU*M* 108

-s o l u t-
C Se E R I : in ap us Es SELIGE 114

-t i o n e n a t u r-
in *Ap* Us : Pt Ai U A Mrs e u S VASUM AB 121

-r a l-
In E u : N Ca IGNE 125

-l i s h u m i d i t a t-
U : N I I S *M*rt E T Ciu A *E* INVESTIGA 134

-t i s e t e c s a u g m-
: *Tp I* ri I r *T* n Smr SI 136

-m e n t o e c s-
Ir R n : e E S Ap I R AES ILLI*C* 144

-s t r a n e a e e t m i h i
n e : Cp U N Smr A Mr Mr ir Rmt T U
CONSUMMAT*U*R 155

c o r d i e s t
n e ir : n *U* t t i *C*p

CHAPTER XIX

The Abbreviated Word about the Green Lion

[Mention[1] was made of *The Abbreviated Word of Brother Raymund about the Green Lion*[2] in Chapter IV, where a short piece of it was used as a basis for showing the method used in the decipherment of the cipher Latin. The text is printed in *Sanioris Medicinae* etc., Frankfurt, 1603, pp. 264–285; it has been accessible to me also in a photograph of a manuscript in the Bodleian Library at Oxford, known as Digby 119. It begins in the middle of folio 77 verso, and the piece of text which I have here transcribed runs to folio 78 recto, middle of line 16.

It will be seen from the following version of the first few lines, that the upper text gives the same absurd jargon which I have taken, I think fairly, as a sign of a cipher-text. It begins:]

"Here begins the abbreviated word of Brother Raymund about the Green Lion.

"An abbreviated word most true and approved, from hidden things enucleated, in brief speech I have abbreviated for you in the work of Sun (=Gold) and Moon (= Silver). First straightway demanding of readers not to hand over such and so great a pearl to be trodden by dogs and pigs; for this is the secret of secrets of all philosophers, a garden of delights and of perfumes of all treasures, which he that has once entered will not further need. But this word, not undeservedly desired by many, was first declared by our famous doctor Roger Bacon, then I, brother Raymund Gaufridi, general minister of the Order of Friars Minor, the word more briefly than I could briefly have arranged to explain to the sons of philosophy."

[1] [The materials for this Chapter were found in Newbold's note-books, with the details of the interpretation carefully worked out. It seems hardly desirable to give another text in the detail with which, for example, the Vatican text was displayed in Chapter XVI.—RGK]

[2] The Green Lion is copper sulphate.

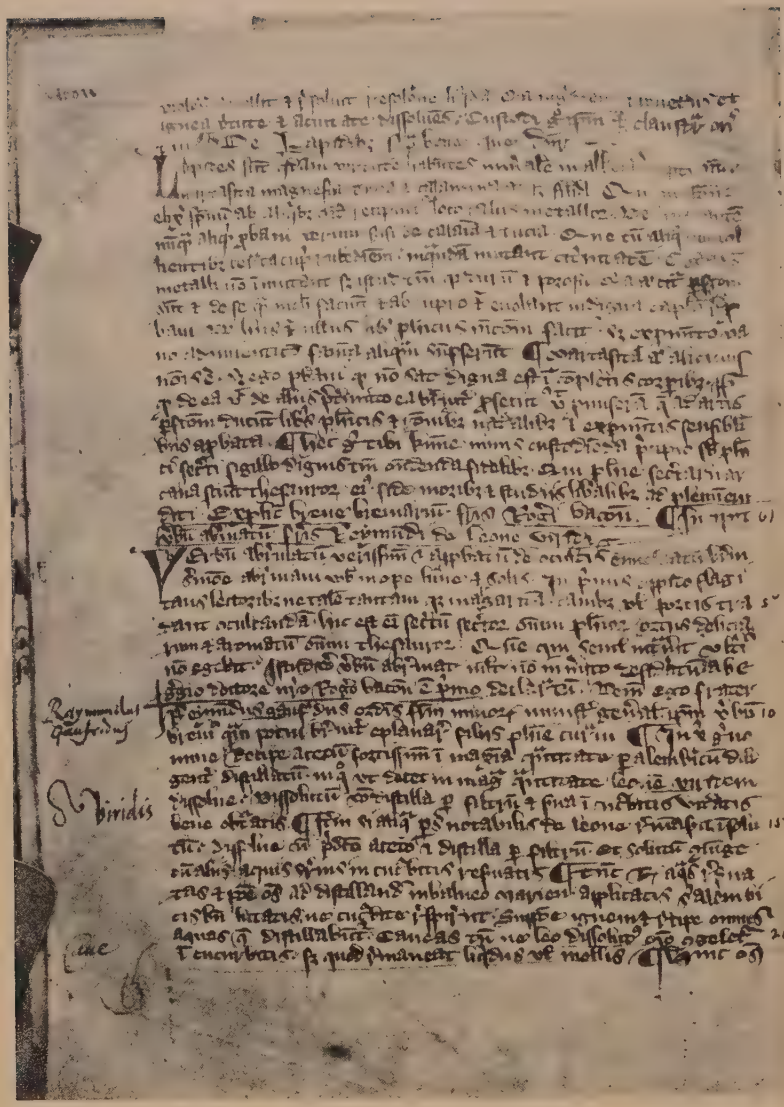

Plate XXXI

The *Verbum Abbreviatum de Leone Viridi*

Bodleian Library, Digby 119, folio 77 verso

The line-numbering has been inserted for convenience of reference

Courtesy of the Bodleian Library

[Another passage from a later part of the treatise[3] may be quoted as showing in an exaggerated degree the nonsensical character of the upper text:]

"And because philosophers figuratively and occultly under an enigma have handed down this science in their doctrines, therefore they have put much error in this most precious stone, and almost all have blocked the way of truth by alien practice, but this, as Rasis says, they did for this reason, that we should operate like them in these things, whence also they said to take the first black and spongy earth, and through certain ways to whiten it and cleanse it from its blackness, which indeed is impossible, and also to make it liquefied, and to render it whiter than snow and more shining than myrrh, and that it is incomparable to every treasure buried in the deep of man, which is not to be conceded, because such earth scarcely or never, as they assert, can be whitened, and if it be whitened it is not being generated. Therefore since we do not intend to show further in our abbreviated word, since all things are thoroughly manifest, in this that we reduce the aforesaid stone to the first substance and well divided of its mercury and sulphur, as has above been said . . ."

[The text of the *Abbreviated Word* corresponding to the deciphered text which I shall give later, is as follows; the superior figures indicate not footnotes, but notes following the text:]

Incipit verbum abbreviatum fratris *Reymundi*[1] de Leone Viridi. Verbum abbreviatum verissimum et approbatum de occultis enucleatum brevi sermone abbreviavi vobis in opere lunae et solis. Imprimis oppido flagitans lectoribus, ne talem tantamque margaritam canibus vel porcis tradant conculcandam: hic est enim secretum secretorum omnium philosophorum, hortus deliciarum et aromatum omnium thesaurorum: quem qui semel intraverit ulterius non egebit. Istud vero verbum *abbreviatum*[2] multis non immerito desideratum ab egregio doctore nostro Rogero *Bacone*[3] est primo declaratum: deinde ego frater *Reymundus*[4] Gaufridus ordinis fratrum minorum minister generalis, ipsum verbum brevius quam potui breviter explanare filiis philosophiae curavi. In Christi ergo nomine recipe acetum fortissimum in maxima quantitate

[3] *San. Med.*, p. 275.

per alembicum diligenter distillatum, in quo ut decet in magna quantitate Leonem viridem dissolve, dissolutum vero distilla per filtrum, et serva in cucurbitis vitreatis bene obturatis. Item si aliqua pars notabilis de Leone remanserit *insolutum*[5] dissolve cum praedicto aceto, et distilla per filtrum, et solutum coniunge cum aliis aquis superius in cucurbitis reservatis; tunc recipe aquas reservatas et pone omnes ad distillandum in balneo *Mariensi*[6] applicatis sibi alembicis bene lutatis ne cucurbitae respirent, suppone ignem et *recipe*[7] omnes aquas quae distillabuntur, caveas tamen ne Leo *dissolutus*[8] congeletur in cucurbitis, sed quod remaneat liquidus vel mollis: hinc omnes *cucurbitas*[9] recipe, et totum quod in eis est, in una cucurbita repone, quam luta bene cum suo alembico, et pone in furno inter cineres *tamusatos*[10] super patellam, aut *trevellenam*[11] terream, sicut decet. Et suppone lentum ignem propter temperationem *vitri*,[12] et propter humiditatem extraneam, quae est in ipso Leone *extirpandam*.[13] Et nota quod istud semper debet fieri cum lento igne: cum vero humiditas extranea exierit, fortifica ignem paulatim, et respicias semper nasum alembici, si humor rubeus exire inceperit. Quod si adhuc non exit, ignem praedictum continua donec exeat, cum vero videris humorem rubeum distillare, continuo muta ampullam, quam luta bene cum rostro alembici, et post fortifica ignem: et recipies ab ipso Leone suum sanguinem mirabiliter rubeum, continentem in se quatuor elementa multum odorifera, et bene fragrantia, serva ergo ipsum in bona ampulla firmiter obturata: deinde recipe ipsum sanguinem, et pone in ampulla bene clausa, ad putrifaciendum, seu digerendum, sub fimo bene calido, mutando fimum de quinque in quinque diebus, ut ibi digeratur per quindecim vel sexdecim dies, et hoc fit, ut dissolvantur partes elementares, et sint aptiores ad dividendum et partiendum per quatu-

[Notes to the Latin text:]

[1] *Reymundi:* [the printed text has *Raymungi*.]

[2] *abbreviatum:* in the manuscript, but not in the printed text.

[3] *Bacone:* the manuscript and the printed text have *Bacon*.

[4] *Reymundus:* [so in manuscript; the printed text has *Raymundus*.]

[5] *insolutum:* so according to the manuscript; but *-ta* in the printed text.

[6] *Mariensi* is the reading of the manuscript, while the printed text has the more usual *Mariae* (indeed I have never seen *Mariensi* elsewhere). If *Mariae* be adopted

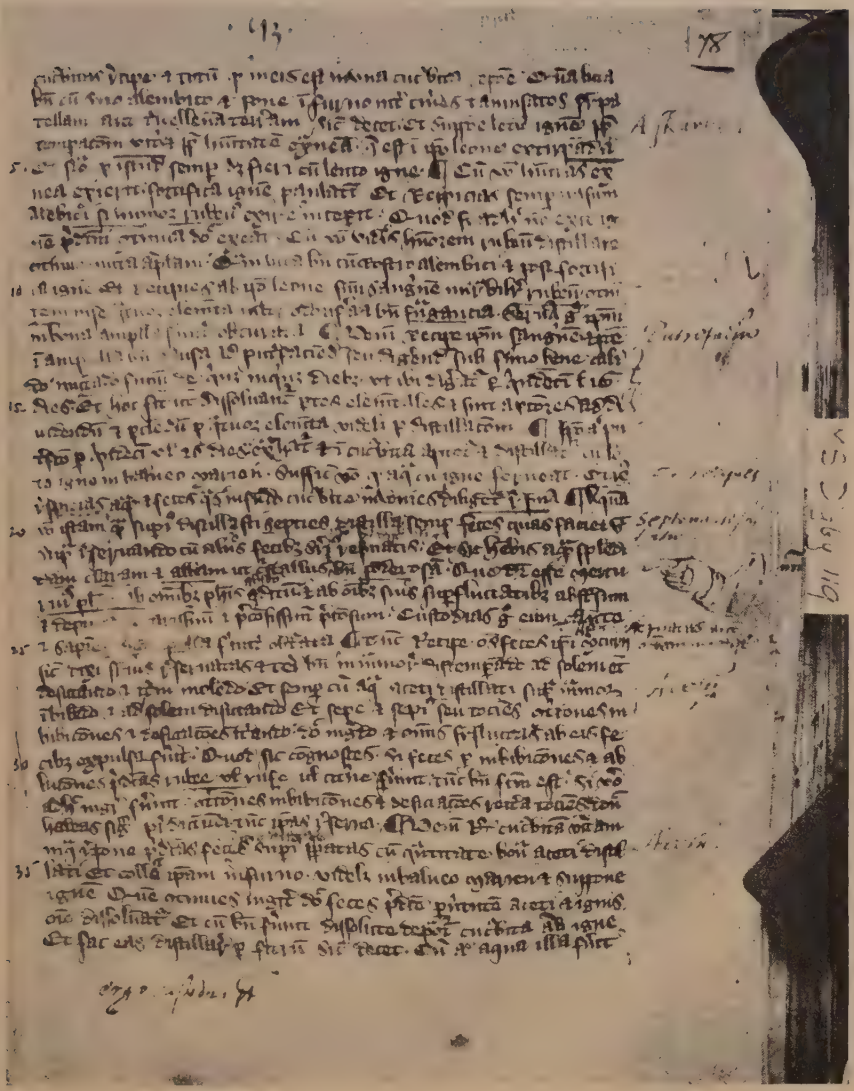

Plate XXXII

The *Verbum Abbreviatum de Leone Viridi*

Bodleian Library, Digby 119, folio 78 recto

The line-numbering has been inserted for convenience of reference

Courtesy of the Bodleian Library

[as the proper reading], one would have [five symbols instead of seven, and] five letters instead of seven in the reconstructed text.

M a r i a e = Mr Tc Ern Irm Lm
M a r i e n s i = Mr Tc Ern I Nemct N L

Omitting the word *in* [in the reconstruction *alte in loco*] and using [Irm as] Mir for M and *-en-* of *bene* [four words later in the cipher Latin] for N [instead of E], one gets ALTE LOCO NYMPHARUM, the remainder of the text not being changed.[4] This use of *loco* in the ablative [without a preposition] is not unknown (v. Kühner, *Ausf. Lat. Gr.*[1] II 258 b), but is unusual. It looks as though Bacon first wrote *Mariae* and later substituted *Mariensi* expressly to introduce the preposition *in*.

[7] *recipe:* the manuscript has *retipe*.

[8] *dissolutus:*[5]

[9] *cucurbitas:* with this word begins folio 78r.

[10] *tamusatos:* so according to the manuscript; cf. *tamisium* or *tamissum* "sieve"; *tumisatos*, [as in the printed text, is] not [to be connected with any word which I find] in the dictionary.

[11] *trevellenam:* [so the manuscript; the nearest word in the dictionaries is] *tribillium* "plate."

[12] *vitri:* reading uncertain.

[13] *extirpandam:* the manuscript has *-ndā*, the printed text has *-ndam*.

[When I started to decipher this text, I found that as usual the first few words, the true title of the treatise, were very clear, coming out with little or no disarrangement:]

I n c i p i t	V e r b u m	A b b r e -
D E V E R O	F I L I O	D S I E
i a i	m t u s	m l
m c c	n c	r
n	e m	

[4] [The Editor cannot see that this will produce the result desired. A comparison of the values of *Mariae* with those of *Mariensi* shows that when I and N in the longer series are thrown out, there is left an *Irm* in the new and shorter set replacing the *N* of the *Nemct* in the longer series. The problem is to secure the *N* and get rid of the *I*. Newbold is right in taking *-ia-* in the value *Mir* instead of *Irm;* but the second step should be to take *-at-* of *applicatis* as *Nme* rather than as *Men*. Thus the superfluous *I* becomes an *M* and the *M* becomes an *N*, which is what is needed.—RGK]

[5] [*Omnino*, abbreviated *oīo*, stands in the manuscript and in the printed text after *dissolutus*, but is disregarded by Newbold in his translation, although he had written the word in a straightaway copy of the text, placing it before *dissolutus* instead of after it.—RGK]

[That is,] DE VERO FILIO DEI, [or "Concerning the True Son of God."

The complete decipherment, so far as I have carried it, is as follows:]

De Vero Filio Dei Christo Iesu. Inane esset caro Filio solo Dei ut mea opinione solus ceu *h*omo spiritus generaretur vivi arte vera Dei. [1]*Ars* naturalis pictrics pingit nova p*h*enomena, ars divina parat vas ecsternale primum seu cupam *vacuum naturis*,[2] et id *sumet*[3] ne viciis ille corporealibus ac ecs eo peioribus cum opinione sincera iis non cessisse teneatur. Temptati sunt *h*omines corporis stimulo. *H*inc Filius Dei spiritus natus sine *specie*[4] vinculorum generatur. Quas Veneri ac vino pingue vile genus vovet carnes generantur ecs immunditie succorum. Iste dicatus Dei Filius incepit a patre gigni, e coelo princeps iit vas animi secum portans ut iniciat semina vitae stipiti *vivorum*.[5] Illorum est essentia a patre *sui*.[6] Isti cuncti sancti sunt et sicut vivit multus si sperat in crucem, ita potest vivis a vivo mystico modo *innocuis*[7] prodire. Tristi via *eunt*[8] in miseram sentinam ilei ecs scroto irruentem maris in vasa testiculorum. Ibi net tina, ibi ictus eat ut in corium ovi. Funis ecstat e vesica et finem iactet et motet. Ille *physice*[9] vivit et ovi est remus alacer ad *ictus*.[10] Inierit succum alte *in*[11] loco nymp*h*arum. Ulterius in eo repat in primarias faeces quas cista ilei e tubis in uteri aditu ecscussas promat spermatis illa funis acu irruat in matris cupam et gemmam intra refigat. Funis ecseat e rima cunni. Liceat ut acus incipiat strias ovo caedere ac lucsare stamina ut ipsius cista mutarit sc*h*ema. Loca in ea eliserit ubi versarit se. *Ille*[12] ovi reticula in cursu scindat et faciat neta ista cunicula in pit*h*o. Ad ea respondeant illic cirri moti arcu faseli et satis acum possint trudere intus. Fetus fiat uteri in arcu. Illic aret vivum satis ut ad*h*aeserit muro primo uteri mucoso. Alat ille eum e scirroso et lupini instar maza illo. Substet tina certo funi; illo instar tubi mearit *h*umor. *Ut*[13] ecs dicto "*coeno*"[14] speciali succorum nutriat se. Succus saturet cupam *vivi*.[15] Spatium stereum inierit acus et secarit in cunicula miscens substantias unam cum altera suspensas in vase in menstruis. Tale ecscidat cor procsime ut unius naturae nodum *h*ic ecssecet venas; indicat locos seligendos animae vitali. Ut erit susceptum aucserit eas mutationes et submittat et subierit eis sub unitatem vivi.

Primo, ilei dicti *venae*[16] suscipiantur de sacrili stipite suo viiij. Ad*h*aeserit r*h*ac*h*iti una vena . . .

[1] *ars.*[6]

[2] *vacuum:* or *vacuam.* *naturis:* or *naturae.*

[3] *sumet:* "substitute."

[4] *specie:* "semblance."

[5] *vivorum:* or *suorum.*

[6] *patre sui:* cf. Kühner, *Lat. Gr.*[1] II 435, n.3.

[7] *innocuis:* cf. Kühner, *Lat. Gr.*[1] II 500.

[8] Cf. Aristot. *Meteor.* IV. 3. 381 b 9: *καὶ ζῷον οὐκ ἐγγίνεται ἐν τῇ πέψει, ὥσπερ τινές φασιν, ἀλλ' ἐν τῇ ἀποκρίσει σηπομένῃ ἐν τῇ κάτω κοιλίᾳ, εἶτ' ἐπανέρχεται ἄνω· πέττεται μὲν γὰρ ἐν τῇ ἄνω κοιλίᾳ, σήπεται δὲ ἐν τῇ κάτω τὸ ἀποκριθέν· δι' ην δ' αἰτίαν, εἴρηται ἐν ἑτέροις.*

[9] *physice:* cf. *Op. Min.* 369. 12.

[10] *ictus:* or *ictum.*

[11] *in:* see note 4 to the text.

[12] Cf. *Comm. Nat.* 278.10: *Mas decindit semen et excitat feminam ad decisionem seminis, et nichilominus semen patris est motor et est, ut dicit Aristoteles, sicut filius unus expulsus de domo patris querens sibi domum, et sicut manus figuli in olla, et penetrat semen matris et facit primum cor. Deinde secundum Aristotelem et Avicennam facit foramina in corde que sunt capita nervorum et venarum, et perforat residuum seminis, faciendo venas et nervos usque ad cerebrum et epar.*

[13] Cf. *C. N.* 276.17: *Et aliquid est commune semini et animato generando et illud est corpus mixtum in potentia ad utrumque, et hec est materia communis utrique.*

Op. Min. p. 359: *Hic autem volens ponere radicalem generationem rerum ostendam quomodo ex elementis generantur humores, et ex humoribus omnia inanimata vegetabilia et animalia et homines.* Cf. p. 365, and *C. N.* p. 15.

[14] In his *Greek Grammar*, pp. 87, 89, Bacon says that the Greek *οι* should be written in Latin *oe.* So probably *coeno* should be read [as the transliteration of] *κοινῷ.*

[15] *vivi:* or *viro.*

[16] *venae:* [According to the] *Encyc. Brit.* II 666c and 667b, the aorta divides at the fourth lumbar vertebra into two branches, the common iliac arteries. Just above and behind the bifurcation the middle sacral is prolonged downward in front of the sacrum to the end of the coccyx. The branches of the aorta which supply the viscera of the abdomen are (1) the coeliac axis, (2) the superior mesenteric, (3) the inferior mesenteric, (4–5) the two capsular, (6–7) the two renal, and (8–9) the two spermatic.

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[6] [The decipherment here given has not been subjected to a final revision. In Chapter IV, Newbold has the word *sic* before *ars*, but this word is not in the older version which is here transcribed.—RGK]

CHAPTER XX

The Tables of Values

[In this Chapter[1] are presented tables of values, showing the building-up of the biliteral system. The Tables are as follows:

I. The Complete Uniliteral Alphabets.
II. The Primary and Secondary Biliteral Alphabets.
III. The Four Complete Biliteral Alphabets.
IV. The Eight Complete Auxiliary Biliteral Alphabets.
V. The Details of the Derivation.
    1. By the Primary Biliteral Alphabets.
    2. By the Secondary Biliteral Alphabets.
    3. By the Auxiliary Alphabets by Conversion.
    4. By the Auxiliary Alphabets by Reversion.
    4*. Values already determined, but not in Newbold's Table VII.
    4°. Values found in Newbold's Table VIII, but not in his Table VII.
    5. Additional Values for Bases, found in Newbold's Table VII.
    6. Values of Non-Bases, derivable by Reversion.
    6*. Values for Symbols omitted from Newbold's Table VII.
    7. Additional Values for Non-Bases, given by Newbold in Table VII, and derivable irregularly.
    8. Values for Non-Bases, given by Newbold in Table VII, and not derivable by the Editor.
VI. The Values for Deciphering.
VII. The Values for Enciphering.
VIII. The Values and Frequency of Occurrence of the First One Thousand Symbols of *The Abbreviated Word about the Green Lion.*
IX. The Values with Commutation, for Deciphering the Voynich Manuscript.]

[1] [In this Chapter, the Editor has added Tables V and IX, and has rearranged Tables IV and VI, as well as some of the explanatory matter at the head of the Tables.—RGK]

Table I

THE COMPLETE UNILITERAL ALPHABETS

Letters of the Key Sentence are given in capitals, and those of the alphabet attached to it are given in minuscules. Letters substituted in the secondary alphabets are put in italics.

The Complete Conversion Alphabet	The Complete Reversion Alphabet
A = g, i, q, y	a = M
B = h	b = I
C = c, *k*	c = C, *Q*
D = f	d = H
E = *q*	e = I
	f = D
	g = A
H = d	h = B
I = b, e, *y*	i = A
	k = *C*
L = o	l = S
M = a, m	m = M, *N*
N = *m*	n = U, *V*
O = t	o = L
P = s	p = T
Q = *c*	q = A, *E*
R = u	r = S
S = l, r, z	s = P
T = p, v	t = O
U = n	u = R
V = *n*	v = T
	y = A, *I*
	z = S

Table II

THE PRIMARY AND SECONDARY BILITERAL ALPHABETS

The First and Fourth Alphabets are written from left to right with their alphabetic values on the right; e.g., *ci* and *hc* both have the value *t*. The Second Alphabet is written in the second column and the Third in the first but both *backward*, so that they must be read from right to left, and their values are given on the left; e.g., *ch* and *ic* both have the value *b*. Italics indicate letters belonging to the secondary uniliteral system; any symbol containing either two or one of these letters, belongs to the secondary bilitera1 system.

The Four Primary Alphabets or "Gates"

a	mi	im	u
b	ci	hc	t
c	to	ti	s
t	no	no	r
i	la	lo	q
i	da	da	p
p	ba	ba	n
c	sm	sa	m
l	ul	um	l
m	ta	tl	c
n	sq	sa	q
p	ua	uq	q
q	tu	ta	i
r	or	ou	t
s	po	pr	c
t	rt	ro	b
u	as	at	a
a	et	it	b

The Four Secondary Alphabets

a	mi	im	u
b	ci	hc	t
c	to	ti	s
t	no	no	r
i	la	lo	q
i	da	da	p
p	b*p*	ba	n
i	*qs*	*qp*	o
c	*nv*	*ns*	m
l	ul	u*v*	l
m	t*c*	tl	c
n	*eq*	*ec*	b
o	sq	s*q*	q
p	ua	uq	q
q	tu	ta	i
r	or	ou	t
s	po	pr	c
t	rt	ro	b
i	*qp*	*q*t	o
o	*is*	*ip*	b
a	et	it	b

Table III

THE FOUR COMPLETE BILITERAL ALPHABETS

The note on Table II applies to this Table also. Two symbols have been introduced into each column from the other merely for the sake of symmetry; they are indicated by parentheses. The phonetic values are added in capitals.

M	a	mi	im	u	R
I	b	ci	hc	t	O
C	c	to	ti	s	P
O	t	no	no	r	S
A	i	la	lo	q	E
A	i	da	da	p	T
T	p	ba	ba	n	U
T	p	b*p*	(b*p*)	n	U
A	i	*q*s	*qp*	o	L
C	c	sm	sa	m	N
C	c	*nv*	*n*s	m	N
S	l	ul	um	l	S
S	l	(u*v*)	u*v*	l	S
N	m	ta	tl	c	C
N	m	t*c*	(t*c*)	c	C
U	n	*eq*	*ec*	b	I
U	n	sq	sa	q	E
L	o	(s*q*)	s*q*	q	E
T	p	ua	uq	q	E
E	q	tu	ta	i	A
S	r	or	ou	t	O
P	s	po	pr	c	C
O	t	rt	ro	b	I
R	u	as	at	a	M
A	i	*qp*	*q*t	o	L
L	o	*is*	*ip*	b	I
M	a	et	it	b	I

Table IV

THE EIGHT COMPLETE AUXILIARY BILITERAL ALPHABETS

These alphabets are derived from the Complete Biliteral Alphabets, given in the preceding table, by conversion and by reversion. The symbols are to be read toward their values, as in Table II.

Values	By Conversion I–III	By Conversion II–IV	By Reversion I–III	By Reversion II–IV	Values
M a	ab ae *ay* mb me *my*	ba bm ea em *ya ym*	ma na	am an	u R
I b	cb ce cy *kb ke ky*	dc *dk*	ca *qa*	bc *bq*	t O
C c	pt vt	pb pe *py* vb ve *vy*	ol	oa	s P
O t	*mt*	*mt*	ul *vl*	ul *vl*	r S
A i	og oi oq oy	ot	sm	sl	q E
A i	fg fi fq fy	fg fi fq fy	hm	hm	p T
T p	hg hi hq hy	hg hi hq hy	im	im	n U
T p	*hs*	(*hs*)	*it*	(*it*)	a U
A i	*cl cr cz*	*cs*	*ap ep*	*at et*	o L
C c	la lm ra rm za zm	lg li lq ly rg ri rq ry zg zi zq zy	pm *pn*	pm	m N
C c	*mn*	*ml mr mz*	*ut vt*	*up vp*	m N
S l	no	na nm	rs	rm rn	l S
S l	(*nn*)	*nn*	(*rt*)	*rt*	l S
N m	pg pi pq py vg vi vq vy	po vo	om	os	c C
N m	*pc pk vc vk*	(*pc pk vc vk*)	*oc oq*	(*oc oq*)	c C
U n	*qc*	*qc qk*	*ia ie*	*ic iq*	b I
U n	*lc rc zc*	lg li lq ly rg ri rq ry zg zi zq zy	pa *pe*	pm	q E
L o	(*lc rc zc*)	*lc rc zc*	(*pa pe*)	*pa pe*	q E
T p	ng ni nq ny	*nc*	rm	ra *re*	q E
E q	pn vn	pg pi pq py vg vi vq vy	or	om	i A
S r	tu	tn	ls	lr	t O
P s	st	su	tl	ts	c C
O t	up uv	ut	so	sl	b I
R u	gl gr gz il ir iz ql qr qz yl yr yz	gp gv ip iv qp qv yp yv	mp	mo	a M
A i	*cs*	*cp cv*	*at et*	*ao eo*	o L
L o	*bl br bz el er ez* *yl yr yz*	*bs es ys*	*ap*	*at*	b I
M a	qp qv	bp bv ep ev *yp yv*	io	ao	b I

Table V

THE DETAILS OF THE DERIVATION

[1: Summary of the Values by the Primary Biliteral Alphabets (cf. Tables II and III):

A	ad al ol ta tu	R	im mi sa ta
P	op rp ti to	M	as at im mi te ti
C	as it ms ot po pr ta tl	N	at lt sa sm
T	ab au da qu	U	as ba ci hc on or ou qs tr
E	at la lo sa sq ua uq ut	S	lu mu no ro ul um uo
I	ch et ic it ro rt		

2: Additional Values by the Secondary Biliteral Alphabets (cf. Tables II and III):

A	pq sq tq	R	pi qp qs qt si
C	sn tc vn	N	ct ns nv
T	pb	U	bp ce qe
I	ec eq ip is	S	uv vu

3: Additional Values in the Auxiliary Alphabets by Conversion (cf. Table IV):

A gf go if io lc pc pg pi pn py qf qo rc sc to
vc vg vi vn vq vy yf yo zc

P pb pe pt py ts us vb ve vt vy

C al ar az bp bv ep ev gl gr gz il ir iz lm ml
mr mz nm pc pg pi pk pq py ql qr qz rm st su
tp tv vc vg vi vk vo vq vy yl yp yr yv yz zm

T cn fg fi fq fy gh gn ih in qh qn sh yh yn

E gp gv ip iv lc lg li lq ly nc ng ni np nq nv
ny og oi oq ot oy qp qv rc rg ri rq ry yp yv
zc zg zi zq zy

I bc bk bl bp br bs bv bz cd ek el ep er es ev
ez kd qc qk qp qv up ut uv yc yk yl yp yr ys
yv yz

R ab ae ay ba bm cl cp cr cs cv cz ea em lb le
lg li lq ly mb me my pg pq py rb re rg ri rq
ry sb se sy vg vi vq vy ya ym zb ze zg zi zq
zy

M ab ae ay ba bm ea em gl gp gr gv gz il ip ir
iv iz mb me my pb pe pq py ql qp qr qv qz vb
ve vq vy ya yl ym yp yr yv yz

N cp cv gp gv ip iv kp kv la lg li lm lq ly ml
mn mr mz op ov qp qv ra rg ri rm rq ry yp yv
za zg zi zm zq zy

U cb cl cq cr cy cz dc dk gl gr gz hg hi hq hs
hy il ir iz kb ke kq ky pu ql qr qz tm tn tu
vu yl yr yz

S an mn mt na nm nn nt on ut

4: Additional Values in the Auxiliary Alphabets by Reversion (cf. Table IV):

A ls mh mz oa oe om or pa pe te
P lt oa ol st
C ao lo mp np oc om oq os pu pv ts tu
T ar er hm mi mr ti
E mo pa pe pm ra re rm ro sl sm
I ac ao ap aq at cb ia ie io iq qb sl so
R nm an ao ap at eo ep et ma na om pa pm
M am an ma mo mp na oa oi
N co mo pm pn qo so up ut vp vt
U ai ap bc bq ca ei ep im it lr ls lu lv mp os qa qi
S mr nr rl rm rn rs rt sl sr tr vl

4*: Values already determined, but not in Newbold's Table VII:

These are for convenience listed here. The superior figures showing how the values were determined are explained at the beginning of Table VI.

A qo^3 vg^3 vq^3 vy^3 yf^3
P vb^3 vt^3
C lm^3 tu^4 vg^3 vq^3 vy^3 yp^3
T mi^4 yh^3 yn^3
E ny^3 qv^3 yv^3 zc^3 zi^3
I bk^3 eq^2 qc^3 qv^3 uv^3 yp^3 yv^3

R vq^3 vy^3 ym^3
M py^3 qv^3 yl^3 ym^3 yr^3 yz^3
N lm^3 ov^3 ut^4 yv^3
U hy^3 on^1 vu^3
S mr^4

The omission in Table VII by Newbold, of T = *mi* and U = *on*, is obviously accidental, since these values are given in Table VIII as occurring in *The Abbreviated Word about the Green Lion*.

4°: Values of Bases found in Newbold's Table VIII, but not in Table VII:

go = C by reversion to ac = mq = ne = vi A^3 C^3 R^3
mi = T^4 (omission from VII is accidental)
og = N by reversion to la E^1 N^3
on = U^1 (omission from VII is accidental)
uc, vc = E by reversion of uc to rc A^3 E^3 and to rq E^3 R^3 N^3

5: Additional Values for Bases, found in Newbold's Table VII.

The following values for bases, given by Newbold in Table VII, are not found in the primary and secondary biliteral alphabets, nor in the auxiliary alphabets, but may be derived by reversion to auxiliary values. The superior figures and signs are explained at the beginning of Table VI. Only values in question are here given:

ai = ma R^4 M^4
ay = mi $^{o}T^4$
bm = in T^3
bq = ie I^4
bs = ip E^3 N^3
em = in T^3
es = ip E^3 M^3 N^3
gh = ab M^3
gn = av = mt S^3
hy = bi = ia = am = mn = mu = mr T^3
ia = am R^4 M^4
mb = ni E^3
me = ni E^3
my = ni E^3
ng = va = tm U^3
ny = vi A^3
ov = lt = so = pl = ts C^3
oy = li E^3 R^3 N^3
py = ti T^4
qc = eq = ie = ai U^3
qz = es = ip = at R^4
rb = si = pa A^4 = tm = om C^4
sb = pi A^3 C^3
se = pi A^3 C^3
sy = pi A^3 C^3
vb = ti T^4
vg = ta = om = lm N^3 = sm E^4 (Editor cannot derive vg = M)
vq = te = oi E^3 = la N^3
vy = ti T^4
ya = im U^4
yf = id = ah = mb = ni E^3
yh = ib = ai U^4 = ma R^4
yl = is = ap R^4
ym = in T^3
yn = iv E^3 N^3
yr = is = ap R^4
ys = ip M^3 = at = mo = ml C^3 = ms A^4

6: Values of Non-Bases, derivable by Reversion.

These values have been obtained by reversion to bases. But any values of the fundamental bases which Newbold did not include in his draft of Table VII as values of the corresponding non-bases, are not here listed. The meaning of the superior figures and diacritical marks is to be found at the head of Table VI.

aa = mm = nn S^3

af = md = nh = { ub = ri E^3 R^3 N^3 / vb P^3 M^3 T^5

ag = ma R^4 M^4

ah = mb R^3 M^3 E^5

ak = mc = nq E^3

av = mt S^3

bb = ii = aa = mm = nn S^3

bd = ih T^3

be = ii = aa = mm = nn S^3

bf = id = ah = mb R^3 M^3 E^5

bg = ia I^4 R^5 M^5

bh = ib = ai U^4 R^5 M^5

bi = ia R^5 M^5 (bi by conversion becomes hy $^{\circ}U^3$)

bn = { iu = ar C^3 T^4 / iv E^3 M^3 N^3

bo = il C^3 M^3 U^3

bt = io A^3 I^4

bu = ir C^3 M^3 U^3

by = { ia I^4 M^5 / ii = aa = mm = nn S^3

cc = cq U^3 and qc I^3 U^5

cf = cd I^3

cg = qa U^4

*ck = qc I^3 U^5

cm = cn T^3 and qn T^3

cu is the same as qu T^1 (see Newbold's note to Table VI)

db = hi U^3

dd = hh = bb = ii = aa = mm = nn S^3

de = hi U^3

df = hd = bh = ib = ai U^4 R^5 M^5

dg = ha = bm R^3 M^3 (Editor cannot derive dg = E)

dh = hb = bi = ia R^5 M^5 (Editor cannot derive dh = T)

di = ha = bm R^3 M^3 T^5

dl = hs U^3

dm = { hm T^4 / hn = { bu = ir C^3 M^3 U^3 / bv C^3 I^3

dn = { hu = br I^3 / hv = bt = io A^3 I^4

do = hl = bs I^3 E^5 N^5 = ip I^2 E^3 M^3 N^3

dp = ht = bo = il C^3 M^3 U^3

dq = he = bi = ia I^4 R^5 M^5

dr = hs U^3

ds = hp = bt = io I^4

dt = ho = bl I^3

du = hr = bs I^3 E^5 N^5 = ip I^2 E^3 M^3 N^3

dv = ht = bo = il C^3 M^3 U^3

dy = { ha = bm R^3 M^3 T^5 / hi U^3

dz = hs U^3

eb = ii = aa = mm = nn S^3

ed = ih T^3

ee = ii = aa = mm = nn S^3

ef = id = ah = mb E^5

eg = ia I^4 R^5 M^5

eh = ib = ai R^5 M^5 (Editor cannot derive eh = I)

en = { iu = ar C^3 T^3 / iv E^3 M^3 N^3

eu = ir C^3 M^3 U^3

ey = { ia I^4 / ii = aa = mm = nn S^3

fa = dm = hn = { bu = ir C^3 M^3 U^3 / bv C^3 I^3

fb = di = ha = bm R^3 M^3 T^5

fc = dc U^3

fd = dh = hb = bi = ia I^4 M^5

fe = di = ha = bm T^5

*ff = dd = hh = bb = ii = aa = mm = nn S^3

fh = db = hi U^3

fk = dc U^3

fl = ds = hp = bt = io A^3 I^4

fm = dm = { hm T^4 ; hn = { bu = ir C^3 M^3 U^3 ; bv C^3 I^3 }

fn = { du = hr = bs I^3 N^5 = ip I^2 M^3 N^3 ; dv = ht = bo U^4 I^5 = il C^3 M^3 U^3 }

fo = dl = hs U^3

fp = dt = ho = bl I^3

fr = ds = hp = bt = io A^3 I^4

fs = dp = ht = bo = il C^3 M^3 U^3

ft = do = hl = bs I^3 E^5 N^5 = ip I^2 E^3 M^3 N^3

fu = dr = hs U^3 = bp = it = ao = ml = ms = np E^3 (Editor cannot derive value E more directly)

fv = dt = ho = bl I^3

fz = ds = hp = bt = io A^3 I^4

ga = am R^4 M^4

gb = ai U^4 R^5 M^5

gc = ac I^4 and aq I^4

gd = ah = mb R^3 M^3 E^5 = { mi R^1 M^1 T^4 ; ni E^3 }

ge = ai U^4 R^5 M^5

gg = aa = mm = nn S^3

gi = aa = mm = nn S^3

gk = ac I^4

gm = am R^4 M^4 and an S^3 R^4 M^4

gq = ae R^3 M^3

gs = ap I^4 U^4 = mt = mo M^4

gt = ao C^4 I^4 R^4

gu = ar C^3 T^4

gy = ai U^4

ha = bm R^3 M^3 T^5

hb = bi = ia R^5 M^5 (bi becomes by conversion hy U^3)

hd = bh = ib = ai U^4 R^5 M^5

he = bi = ia R^5 M^5 (bi becomes by conversion hy U^3)

hf = bd = ih T^3

hh = bb = ii = aa = mm = nn S^3

hk = bc I^3 U^4

hl = bs I^3 E^5 N^5 = ip I^2 E^3 M^3 N^3

hn = { bu = ir C^3 M^3 U^3 ; bv C^3 I^3 }

ho = bl I^3

hp = bt = io A^3 I^4

hr = bs I^3 E^5 N^5 = ip I^2 E^3 M^3 N^3

ht = bo = il C^3 M^3 U^3

hu = br I^3

hv = bt = io A^3 I^4

hz = bs I^3 M^5 N^5 = ip I^2 E^3 M^3 N^3

ib = ai U^4 R^5 M^5

id = ah = mb R^3 M^3 E^5

ig = aa = mm = nn S^3

ii = aa = mm = nn S^3

ik = ac I^4

iu = ar C^3 T^4

iy = ai U^4

ka = cm = cn T^3 and qn T^3

kc = { cq U^3 ; cc = qc I^3 U^5 }

kf = cd I^3

kg = ca U^4

kh = cb U^3 I^4

ki = ca U^4

kk = cc = qc I^3 U^5 and cq U^3

kl = cs R^3

km = cn T^3

kn = cv R^3 N^3 and cu T^7

ko = cl R^3 U^3

kr = cs R^3

ks = cp R^3 N^3

kt = co N^4

ku = cr R^3

kz = cs R^3

ld = sh T^3

lf = sd = ph = tb = oi E^3 M^4

lh = sb R^3 A^5 C^5

*lk = sc A^3

ll = ss = pp = tt = oo, which is the same as ou U^1 and uo S^1

ln = { su C^3 ; sv = pt P^3 }

lp = st P^4 C^5

lz = ss = pp = tt = oo, which is the same as ou U^1 and uo S^1

mc = nc E^3 and nq E^3

md = { mh A^4 ; nh = { ub = ri E^3 R^3 N^3 ; vb P^3 M^3 T^5 }

mf = nd = { uh = rb R^3 A^5 ; vh = tb = oi E^3 M^4 }

mg = na S^3 R^4 M^4

mk = nc E^3

mm = nn S^3

mq = ne = { ui = ra E^4 ; vi = A^3 C^3 R^3 }

mv = nt S^3

nb = { ui = ra N^3 E^4 ; vi A^3 C^3 R^3 }

nd = { uh = rb R^3 ; vh = tb = oi E^3 M^4 }

ne = { ui = ra N^3 E^4 ; vi A^3 C^3 R^3 }

nf = { ud = rh = sb R^3 A^5 ; vd = th = ob = li E^3 R^3 N^3 }

nh = { ub = ri E^3 R^3 N^3 ; vb P^3 M^3 T^5 }

nk = { uc = rc A^3 E^3 and rq E^3 ; vc A^3 C^3 }

nl = { us P^3 ; vs = tp C^3 }

nl becomes by conversion mo N^4

nu = { ur = rs S^4 ; vr = ts P^3 C^3 }

nz = vs = tp C^3

ob = li E^3 R^3 N^3

od = lh = sb R^3 A^5 C^5

of = ld = sh T^3

oh = lb R^3

ok = lc A^3 E^3

oo is the same as ou U^1 and uo S^1

oz = ls A^4 U^4

pd = th = ob = li E^3 R^3 N^3

pf = td = oh = lb R^3

ph = tb = oi E^3 M^4

pl = ts P^3 C^3

pp = tt = oo which is the same as ou U^1 and uo S^1

ps = tp C^3

pz = ts P^3 C^3

qd = eh = ib = ai U^4 R^5 M^5

qg = ea R^3 M^3

qm = { em R^3 M^3 T^5 ; en = { iu = ar C^3 T^4 ; iv E^3 M^3 N^3 }

qq = ee = ii = aa = mm = nn S^3

qy = ei U^4

rd = sh T^3

rf = sd = ph = tb = oi E^3 M^4

rh = sb R^3 A^5 C^5

rk = sc A^3

rr = ss = pp = tt = oo which is the same as ou U^1 and uo S^1

ru = sr S^4

rv = st P^4 C^5

rz = ss = pp = tt = oo which is the same as ou U^1 and uo S^1

sd = ph = tb = oi E^3 M^4

sf = pd = th = ob = li E^2 R^3 N^3

sg = pa A^4 E^4 R^4

sk = pc A^3 C^3

sp = pt P^3

ss = pp = tt = oo which is the same as ou U^1 and ou S^1

sv = pt P^3

sz = ps = tp C^3

tb = oi E^3 M^4

td = oh = lb R^3

tf = od = lh = sb R^3 A^5 C^5

tg = oa A^4 P^4 M^4

th = ob = li E^3 R^3 N^3

tk = oc C^4

tt = oo which is the same as ou U^1 and uo S^1

ty = oa A^4 P^4 M^4 and oi M^4

(Editor cannot derive ty = T)

tz = os C^4 U^4

ub = ri E^3 R^3 N^3

uc = rc A^3 E^3 and rq E^3

ud = rh = sb R^3 A^5 C^5

ue = ri E^3 R^3 N^3

uf = rd = sh T^3

ug = ra N^3 E^4

uh = rb R^3

ui = ra N^3 E^4
uk = rc A^3 E^3
un = { ru = sr S^4 / rv = st P^4 C^5 }
ur = rs S^4
uu is the same as ou U^1 and ou S^1
uy = ri E^3 R^3 N^3
uz = rs S^4
va = tm U^3
vd = th = ob = li E^3 R^3 N^3
vf = td = oh = lb = si = pa E^4
(Editor cannot derive vf = M)
vh = tb = oi E^3 M^4
vm = tm U^3 and tn U^3
vr = ts P^3 C^3
vs = tp C^3
vv = tt = oo which is the same as ou U^1 and uo S^1
vz = ts P^3 C^3
yb = ii = aa = mm = nn S^3
yd = ih T^3
ye = ii = aa = mm = nn S^3
yg = ia I^4
yi = ia I^4 R^5

*yq = ie I^4
yt = io I^4 = al C^3 = ms C^1 = np E^3 C^4
yu = ir C^3 M^3 U^3
yy = ii = aa = mm = nn S^3
*zd = sh T^3
zf = sd = ph = tb = oi E^3 M^4
zh = sb A^5 C^5
zk = sc = pq R^3
zl = ss = pp = tt = oo which is the same as ou U^1 and uo S^1
zn = { su C^3 / sv = pt P^3 }
zo = sl E^4 I^4 S^4
zp = st P^4 C^5
zr = ss = pp = tt = oo which is the same as ou U^1 and uo S^1
zs = sp = pt P^3
zt = so I^4 N^4
zu = sr S^4
zv = st P^4 C^5
(Editor cannot derive zv = E)
zz = ss = pp = tt = oo which is the same as ou U^1 and uo S^1]

[6*: Values for Symbols omitted from Newbold's Table VII.

The following biliteral symbols were not listed in Newbold's Table VII, and the values assigned to them rest therefore solely on the calculations of the Editor:

ck = I U ff = S lk = A yq = I zd = T

7: Additional Values for Non-Bases, given by Newbold in Table VII, and derivable irregularly.

The following values for non-bases, given by Newbold in Table VII, are derivable, but not merely by regular reversion:

(By conversion) bi = U; hb = U; he = U; nl = N
(By cu = qu, p. x) cu = T; kn = T
(By oo = ou and uo, p.88) ll lz oo pp rr rz ss tt uu vv zl zr zz } = U S

8: Values for Non-Bases, given by Newbold in Table VII, and not derivable by the Editor.

The following values for non-bases were given by Newbold in Table VII, but cannot be derived by the Editor. They have been allowed to remain, however, since the error may be on the part of the Editor rather than on that of Newbold:

dg = E; dh = T; eh = I; ty = T; vf = M; zv = E]

Table VI

THE VALUES FOR DECIPHERING

[This Table presents the values of the various symbols in Bacon's phonetic alphabet of eleven letters. Some preliminary observations must first be made, which follow at this point:]

Relation of the Secondary Values to the Primary:

Since the secondary system of values[2] was invented in order to increase the number of possible equivalents, they do not replace those of the primary system. For example, the base *ip* had in the primary system the values E M N. When it was reintroduced in the secondary system by the substitution of *qpi* for the *a* of *portas*, it acquired the additional value of I. Thenceforward it had in theory all four values. But in practice, Bacon betrays a decided tendency to use these polyvalent symbols in only one of their possible values. Thus *ip* is usually E or I, very seldom M or N. I have not, however, been able to discover any fixed rule determining his practice. Take for example the symbols *es* and *se*: in the primary system they reduce to *ip* = E M N and *pi* = A C R; in the secondary they are themselves bases, *es* = I and *se* = R. In practice, *es* is, I think, always I; at least I have never found it in a context requiring or even suggesting any other value. But *se*, although it usually has its secondary value R, is not infrequently used in the primary value A.

The introduction of the secondary system implied the right to attribute even to the bases of the primary system new values derived from the secondary. In the primary system, for example, *me* and *em* are bases derived from *mi* and *im*, both having the values M R. But in the secondary system they would revert to the primary bases *ni* = E and *in* = T respectively, and in practice these values have almost if not entirely displaced M R.

In Table VI, I have as a rule given both the primary and the secondary values, but in giving the *derived* values of the symbols beginning with *y* I have given the secondary values only; i.e., those reached by reversing *y* to *i*, and not, as in the primary system, to *a*, my reason being that in all the few occurrences of symbols containing *y* which I have as yet encountered, this mode of reversion alone is used.[3]

[2] [By the primary system, Newbold means the values given by the primary biliteral alphabets and by conversion and reversion to these values; by the secondary system,

V and U:

Bacon, following the fifth century grammarian Priscian, clearly recognizes the difference between the vowel U and the consonant V, and also that between I and J, but knows nothing of any attempt to distinguish the difference by the use of different characters; U and V, I and J, were used for both sounds. Thus he says in his *Oxford Greek Grammar*, pp. 49–50 (edition of Nolan and Hirsch, Cambridge, 1902): "There remain two sounds, namely the consonants V and J, which form new letters by virtue of their sounds, quite different from themselves as vowels, and indeed different from all the others. And although the consonant V is related in sound to the letter F (for which reason the ancients sometimes used the consonant V in place of the Aeolic digamma, which is F itself), still, since it has been shown that P and F have the same sound in the syllable, the sound of this consonant letter V will be different from its sound as F because the sound of the consonant V is different from that of P. And although the consonant J sometimes has a sound similar to that of G, as when we say *legerat* and *Iesus*, still the consonant G sometimes has a sound of its own different from that of the consonant J, as in *gallus*. And because V and J thus pass over from the vowel sound to the consonant, says Priscian, in my opinion they should be taken not as the same letters, but as entirely different according as they are vowel or consonant. And so, as regards their sound, they are different letters of the alphabet, if we are to speak accurately; *although their forms and their names are the same*. For just as K and G and C are the same letter of the alphabet because their sounds are essentially and in effect the same, so also V and J, since their sounds are essentially different when they are vowels and when they are consonants, will be different letters of the alphabet, even though they retain the same name and shape: so argues Priscian."

Bacon's statement is borne out by the practice of the scribes of

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he means the additional values given the secondary biliteral alphabets and by conversion and reversion to these values.—RGK]

[3] [The Editor has in Table V 6 followed this direction, so far as was consistent with his being able to derive the values which he found listed in Newbold's draft of Table VII. In but four symbols was he obliged to revert *y* to *a*: *by*, *dy*, *ey*, *ty*. It must not be forgotten that Table V is entirely the work of the Editor, and that Table VI has been entirely rearranged.—RGK]

his age. Both V and U are used for both the vowel and the consonant; one finds, for example, both *ut* and *vt*, both *vult* and *uult*. Hence the distinction drawn by Bacon in his cipher between V and U is graphic only; it has no relation whatever to the sounds of the letters. It follows, therefore, that in these Tables any symbol written with a U may also be written with a V *except when it expresses a distinction already drawn by Bacon himself*. For example, the symbol *qu* = T may be written either *qu* or *qv*, but *qv* = I cannot because it is the converse of *et*, and *t* converts to *v* only, not to *u*.

But this "graphic" distinction finds no representation in the written Latin cipher. Bacon's object in drawing this distinction was, as I have already said, to increase the number of values assigned those syllables containing a U which occur so frequently in Latin as inflectional endings. For example, in writing the first thousand letters[4] of the text underlying *The Green Lion*, Bacon used 173 [different] symbols. Five symbols, *tu ru um ur us*, less than three percent [of the total number of different symbols], express 78 letters, or 14.7 percent of the total number of letters.[5] It was therefore necessary to give these symbols many values to avoid crowding into the text letters at points where they were not needed. If he had laid down the rule that *ıum* must be analyzed into *tu um* and *tvm* into *tv vm*, he would have imposed upon himself restrictions which would have defeated the end in view. Hence either of these syllables[6] must be analyzed into *tu* or *tv* and *um* or *vm*, and must be given the values of *both the U and the V forms*. In practice, therefore, these symbols are not distinguished: *tu* = U A and also C, *um* = S and also U, *ur* = S and also C P.

So also in reducing symbols to their bases. Take for example the word *nunc*. It resolves into *nu un nc*. *nu*, taken as the base *nv*, has the values N E; taken as *nu* it is not basic and must be reduced. It reverts to *ur* and *vr*, neither of which is basic. But *ur*

[4] [See Table VIII. Apparently Newbold means in the first 1000 symbols, which takes about 1150 letters, since the initial and final letters of the words are not doubled, and a word therefore has one "symbol" fewer than its number of letters.—RGK]

[5] [That is, 78 letters of the underlying or true text, and 14.7 per cent of the letters of the upper text; every symbol contains two letters, few of which overlap other symbols in the list concerned, and therefore these symbols, 78 in number, contain nearly twice this number of individual letters.—RGK]

[6] [Or rather writings: *tum* or *tvm*.—RGK]

reverts to *rs* = S and *vr* to *ts* = C P. Thus the *nu* occurring in *nunc* has no less than five phonetic values, N E C P S. In like manner the *un*, if taken as the base *vn*, has the values C A; but if taken as *un* it reduces to *sr* and *st* with the values S C P. The final symbol *nc* is itself a base, with the value E.

Q and C:

The symbol *cu* is not a base; taken as *cv*, it is a base in the secondary system and equals R N. If reduced, *cu* reverts to *cr* = U R and *qr* = C M U. No other values can be deduced by the rules of the cipher. Yet experience proves that the most common value of *cu* is T. I can explain this upon one assumption only, namely, that in the earliest form of the primary system, in which Q did not occur, Q was not distinguished from C, and the word *quatuor*, from the first syllable of which the value *qu* = T is derived, was written *cuatuor*. Another trace of the same early practice is seen in the commutation rules, in which also Q has the value of C (see pp. 99–100).[7]

Symbols containing K:

As I have assumed (p. 82) that Bacon introduced K into the secondary alphabet as an equivalent for C, so also I have assumed that K occurs in the alphabet from which the symbols are derived, thus giving rise to a complete set of symbols ending and beginning in K. This assumption can be tested in no other way than by comparing the values thus deduced from the rules of the cipher, with those actually occurring in cipher texts, and since K-symbols occur very seldom, the evidence upon which they rest is scanty and not entirely conclusive. It is, I think, possible that K was not recognized as a letter, but was treated as a variant form of C.

[7] [In view of these data, it may fairly be asked if Q had a real separate existence in Bacon's system. When Newbold wrote the text of what is now Chapter IV, he still regarded Bacon's alphabet as containing 22 letters and not 23; before his death he changed the number in the manuscript. The text of the Tables, so far as he prepared them, implies the 23-letter alphabet. But in his interpretation of the shorthand cipher text underlying the Key, given on pages 113–18, he shows that he still regarded Bacon's alphabet as having but 22 letters; i.e., as lacking the *q*. Further, in the shorthand characters themselves, the *q* is distinguishable from the *c* only in size, according to Newbold; and as both are microscopic, one may doubt whether they are to be distinguished. The Editor calls attention to this problem without having any view of his own on the point.—RGK]

[The complete list of values of the symbols now follows, with indication of the way in which the values were derived, as follows:

* Derived by the Editor, but not given in Newbold's draft of Table VII.

° Used in Newbold's manuscript or in Table VIII, but not listed in his Table VII.

1–5 Values of Bases

1 by the primary biliteral alphabets.

2 by the secondary biliteral alphabets.

3 by the auxiliary biliteral alphabets, by conversion.

4 by the auxiliary biliteral alphabets, by reversion.

5 derived otherwise by Newbold.

6–8 Values of Non-Bases

6 derived by reversion.

7 given in Newbold's draft of Table VII, and derivable, but not by direct reversion.

8 given in Newbold's draft of Table VII, but not derivable by the Editor.

The details of these steps may be found in the several parts of Table V, numbered correspondingly.

Symbols having values with exponent figures 1 to 5, are bases; those having values with exponent figures 6 to 8, are non-bases.]

Values in capitals are the values in common use; those in small letters are valid in principle, but seem to have been used rarely or not at all by Bacon.

aa	s^6	ba	$R^3 M^3 U^1$	ca	U^4
ab	$T^1 r^3 M^3$	bb	S^6	cb	$i^4 u^3$
ac	I^4	bc	$i^3 u^4$	cc	$I^6 U^6$
ad	A^1	bd	t^6	cd	I^3
ae	$R^3 M^3$	be	S^6	ce	U^2
af	$P^6 T^6 e^6 r^6 m^6 n^6$	bf	$e^6 r^6 m^6$	cf	i^6
ag	$R^6 M^6$	bg	$i^6 R^6 M^6$	cg	u^6
ah	$E^6 r^6 m^6$	bh	$R^6 M^6 u^6$	ch	I^1
ai	$R^5 M^5 U^4$	bi	$R^6 M^6 U^7$	ci	U^1
ak	e^6	bk	$*i^3$	ck	$*i^6 *u^6$
al	$A^1 C^3$	bl	I^3	cl	$R^3 u^3$
am	$R^4 M^4$	bm	$t^5 r^3 m^3$	cm	t^6
an	$r^4 M^4 S^3$	bn	$c^6 t^6 E^6 m^6 n^6$	cn	T^3
ao	$c^4 i^4 r^4$	bo	$C^6 M^6 U^6$	co	N^4
ap	$I^4 r^4 u^4$	bp	$c^3 i^3 u^2$	cp	$r^3 n^3$
aq	I^4	bq	$i^5 u^4$	cq	U^3
ar	$C^3 t^4$	br	I^3	cr	$R^3 u^3$
as	$C^1 M^1 U^1$	bs	$E^5 I^3 n^5$	cs	R^3
at	$E^1 i^4 r^4 M^1 n^1$	bt	$A^6 I^6$	ct	N^2
au	T^1	bu	$C^6 M^6 U^6$	cu	T^7
av	S^6	bv	$C^3 I^3$	cv	$R^3 N^3$
ay	$T^5 r^3 m^3$	by	$i^6 m^6 s^6$	cy	u^3
az	c^3	bz	i^3	cz	$r^3 u^3$

da	T^1	ea	$R^3 M^3$	fa	$C^6 i^6 M^6 U^6$
db	u^6	eb	S^6	fb	$t^6 R^6 m^6$
dc	u^3	ec	I^2	fc	u^6
dd	S^6	ed	T^6	fd	$i^6 m^6$
de	U^6	ee	S^6	fe	T^6
df	$R^6 m^6 u^6$	ef	E^6	ff	$*s^6$
dg	$e^8 r^6 m^6$	eg	$i^6 R^6 M^6$	fg	t^3
dh	$t^8 R^6 m^6$	eh	$i^8 R^6 M^6$	fh	u^6
di	$T^6 r^6 m^6$	ei	U^4	fi	T^3
dk	u^3	ek	i^3	fk	u^6
dl	U^6	el	I^3	fl	$A^6 I^6$
dm	$c^6 t^6 i^6 m^6 u^6$	em	$T^5 r^3 m^3$	fm	$c^6 t^6 i^6 m^6 u^6$
dn	$a^6 i^6$	en	$C^6 t^6 E^6 m^6 n^6$	fn	$c^6 i^6 m^6 n^6 u^6$
do	$E^6 I^6 m^6 n^6$	eo	R^4	fo	U^6
dp	$c^6 m^6 u^6$	ep	$C^3 I^3 r^4 u^4$	fp	i^6
dq	$i^6 r^6 m^6$	eq	$*i^2$	fq	t^3
dr	U^6	er	$t^4 I^3$	fr	$A^6 I^6$
ds	I^6	es	$e^5 I^3 m^5 n^5$	fs	$c^6 m^6 u^6$
dt	I^6	et	$I^1 R^4$	ft	$e^6 I^6 m^6 n^6$
du	$E^6 I^6 m^6 n^6$	eu	$C^6 m^6 u^6$	fu	$E^6 U^6$
dv	$c^6 m^6 u^6$	ev	$C^3 I^3$	fv	I^6
dy	$t^6 r^6 m^6 u^6$	ey	$i^6 s^6$	fy	t^3
dz	u^6	ez	i^3	fz	$a^6 i^6$

ga	$R^6 M^6$	ha	$T^6 r^6 m^6$	ia	$I^4 R^5 M^5$
gb	$R^6 m^6 u^6$	hb	$R^6 m^6 u^7$	ib	$R^6 M^6 U^6$
gc	i^6	hc	u^1	ic	I^1
gd	$t^6 e^6 r^6 m^6$	hd	$R^6 m^6 u^6$	id	$E^6 r^6 m^6$
ge	$R^6 M^6 U^6$	he	$R^6 M^6 U^7$	ie	I^4
gf	a^3	hf	t^6	if	A^3
gg	S^6	hg	u^3	ig	S^6
gh	$t^3 m^5$	hh	s^6	ih	T^3
gi	S^6	hi	U^3	ii	S^6
gk	i^6	hk	$i^6 u^6$	ik	i^6
gl	$C^3 M^3 U^3$	hl	$e^6 I^6 m^6 n^6$	il	$C^3 M^3 U^3$
gm	$R^6 M^6 S^6$	hm	t^4	im	$R^1 M^1 U^4$
gn	$T^3 S^5$	hn	$c^6 i^6 m^6 u^6$	in	T^3
go	$A^3 {}^\circ c^5$	ho	I^6	io	$A^3 I^4$
gp	$e^3 m^3 n^3$	hp	$a^6 i^6$	ip	$E^3 I^2 m^3 n^3$
gq	$r^6 m^6$	hq	u^3	iq	I^4
gr	$C^3 M^3 U^3$	hr	$E^6 I^6 M^6 n^6$	ir	$C^3 M^3 U^3$
gs	$I^6 m^6 u^6$	hs	u^3	is	I^2
gt	$c^6 I^6 R^6$	ht	$c^6 m^6 u^6$	it	$c^1 I^1 U^4$
gu	$C^6 t^6$	hu	I^6	iu	$C^6 T^6$
gv	$E^3 M^3 n^3$	hv	$A^6 I^6$	iv	$E^3 m^3 n^3$
gy	u^6	hy	$t^5 {}^*u^3$	iy	u^6
gz	$c^3 m^3 u^3$	hz	$e^6 i^6 m^6 n^6$	iz	$c^3 m^3 u^3$

ka	t^6	la	$E^1 N^3$	ma	$R^4 M^4$
kb	u^3	lb	R^3	mb	$E^5 r^3 m^3$
kc	$i^6 u^6$	lc	$A^3 E^3$	mc	E^6
kd	i^3	ld	T^6	md	$a^6 p^6 t^6 e^6 r^6 m^6 n^6$
ke	u^3	le	R^3	me	$E^5 r^3 m^3$
kf	i^6	lf	$e^6 M^6$	mf	$a^6 e^6 R^6 m^6$
kg	u^6	lg	$E^3 r^3 N^3$	mg	$R^6 M^6 s^6$
kh	$i^6 u^6$	lh	$a^6 c^6 r^6$	mh	A^4
ki	u^6	li	$E^3 r^3 N^3$	mi	$R^1 M^1 {}^\circ t^4$
kk	$i^6 u^6$	lk	$^*a^6$	mk	e^6
kl	r^6	ll	$U^7 S^7$	ml	$c^3 n^3$
km	t^6	lm	$^*c^3 {}^*n^3$	mm	S^6
kn	$t^7 r^6 n^6$	ln	$P^6 C^6$	mn	$N^3 S^3$
ko	$r^6 u^6$	lo	$C^4 E^1$	mo	$E^4 m^4 N^4$
kp	n^3	lp	$P^6 C^6$	mp	$C^4 M^4 U^4$
kq	u^3	lq	$e^3 r^3 N^3$	mq	$a^6 c^6 E^6 r^6$
kr	r^6	lr	U^4	mr	$c^3 T^3 N^3 {}^*s^4$
ks	$r^6 n^6$	ls	$A^4 U^4$	ms	$A^4 C^1$
kt	n^6	lt	$P^4 N^1$	mt	S^3
ku	r^6	lu	$U^4 S^1$	mu	S^1
kv	n^3	lv	U^4	mv	S^6
ky	u^3	ly	$e^3 r^3 n^3$	my	$e^5 r^3 m^3$
kz	r^6	lz	$u^7 s^7$	mz	$c^3 n^3$

na	$r^4 M^4 S^3$	oa	$a^4 p^4 m^4$	pa	$a^4 e^4 R^4$
nb	$A^6 c^6 E^6 r^6 n^6$	ob	$E^6 r^6 n^6$	pb	$p^3 t^2 m^3$
nc	E^3	oc	C^4	pc	$a^3 c^3$
nd	$E^6 R^6 m^6$	od	$A^6 c^6 R^6$	pd	$e^6 r^6 n^6$
ne	$A^6 c^6 E^6 r^6 N^6$	oe	A^4	pe	$A^4 P^3 E^4 m^3$
nf	$a^6 e^6 r^6 n^6$	of	T^6	pf	r^6
ng	$E^3 U^5$	og	$E^3 {}^{\circ}n^5$	pg	$a^3 c^3 r^3$
nh	$p^6 t^6 e^6 r^6 m^6 n^6$	oh	R^6	ph	$E^6 M^6$
ni	E^3	oi	$E^3 M^4$	pi	$A^3 c^3 R^2$
nk	$a^6 c^6 e^6$	ok	$a^6 e^6$	pk	c^3
nl	$p^6 c^6 n^7$	ol	$A^1 P^4$	pl	$P^6 C^6$
nm	$C^3 S^3$	om	$A^4 c^4 r^4$	pm	$e^4 r^4 n^4$
nn	S^3	on	${}^{\circ}U^1 S^3$	pn	$a^3 n^4$
no	S^1	oo	$U^7 S^7$	po	C^1
np	$C^4 E^3$	op	$P^1 N^3$	pp	$U^7 S^7$
nq	E^3	oq	$C^4 E^3$	pq	$a^2 c^3 r^3 m^3$
nr	S^4	or	$A^4 U^1$	pr	C^1
ns	N^2	os	$C^4 U^4$	ps	C^6
nt	S^2	ot	$C^1 E^3$	pt	P^3
nu	$P^6 c^6 s^6$	ou	U^1	pu	$C^4 U^3$
nv	$E^3 N^3$	ov	$C^5 {}^*n^3$	pv	C^4
ny	$a^5 {}^*e^3$	oy	$e^3 r^5 n^5$	py	$a^3 p^3 c^3 t^5 r^3 {}^*m^3$
nz	c^6	oz	$a^6 u^6$	pz	$p^6 c^6$

qa	u^4	ra	$E^4 N^3$	sa	$E^1 r^1 N^1$
qb	i^4	rb	$a^5 c^5 R^3$	sb	$a^5 c^5 R^2$
qc	${}^*i^3 u^5$	rc	$A^3 E^3$	sc	A^3
qd	$r^6 m^6 u^6$	rd	T^6	sd	$E^6 M^6$
qe	u^2	re	$E^4 R^3$	se	$A^5 c^5 R^3$
qf	a^3	rf	$E^6 M^6$	sf	$e^6 r^6 n^6$
qg	$r^6 m^6$	rg	$E^3 r^3 N^3$	sg	$a^6 e^6 R^6$
qh	t^3	rh	$a^6 c^6 r^6$	sh	T^3
qi	u^4	ri	$E^3 r^3 N^3$	si	R^2
qk	i^3	rk	a^6	sk	$a^6 c^6$
ql	$c^3 m^3 u^3$	rl	S^4	sl	$E^4 i^4 s^4$
qm	$c^6 t^6 e^6 r^6 m^6 n^6$	rm	$c^3 e^4 N^3 S^4$	sm	$E^4 N^1$
qn	t^3	rn	S^4	sn	C^2
qo	${}^*a^3 n^4$	ro	$E^4 I^1 S^1$	so	$I^4 N^4$
qp	$e^3 i^3 r^2 m^3 n^3$	rp	P^1	sp	P^6
qq	s^6	rq	$e^3 r^3 n^3$	sq	$A^2 E^1$
qr	$c^3 m^3 u^3$	rr	$U^7 S^7$	sr	s^4
qs	$R^2 u^1$	rs	S^4	ss	$U^7 S^7$
qt	R^2	rt	$I^1 S^4$	st	$P^4 C^3$
qu	T^1	ru	S^6	su	C^3
qv	${}^*e^3 {}^*i^3 {}^*m^3 n^3$	rv	$P^6 C^6$	sv	P^6
qy	u^6	ry	$e^3 r^3 n^3$	sy	$a^5 c^5 r^3$
qz	$c^3 r^5 m^3 u^3$	rz	$u^7 s^7$	sz	c^6

ta	$A^1\ c^1\ r^1$	ua	E^1	va	U^6
tb	$e^6\ m^6$	ub	$E^6\ r^6\ N^6$	vb	$*p^3\ T^5\ M^3$
tc	c^2	uc	$a^6\ {}^\circ e^6$	vc	$A^3\ c^3$
td	r^6	ud	$A^6\ c^6\ R^6$	vd	$E^6\ R^6\ N^6$
te	$A^4\ M^1$	ue	$e^6\ r^6\ N^6$	ve	$P^3\ M^3$
tf	$a^6\ c^6\ r^6$	uf	T^6	vf	$E^6\ M^8$
tg	$a^6\ p^6\ m^6$	ug	$e^6\ N^6$	vg	$*a^3\ *c^3\ E^5\ r^3\ M^5\ N^5$
th	$E^6\ r^6\ N^6$	uh	R^6	vh	$e^6\ m^6$
ti	$P^1\ T^4\ m^1$	ui	$e^6\ N^6$	vi	$A^3\ c^3\ r^3$
tk	c^6	uk	$a^6\ e^6$	vk	c^3
tl	C^1	ul	S^1	vl	S^4
tm	u^3	um	S^1	vm	U^6
tn	u^3	un	$P^6\ C^6\ s^6$	vn	$a^3\ C^2$
to	$A^3\ P^1$	uo	S^1	vo	C^3
tp	c^3	up	$I^3\ N^4$	vp	N^4
tq	a^2	uq	E^1	vq	$*a^3\ *c^3\ e^5\ *r^3\ M^3\ n^5$
tr	$U^1\ S^4$	ur	S^6	vr	$P^6\ C^6$
ts	$P^3\ C^4$	us	P^3	vs	C^6
tt	$U^7\ S^7$	ut	$E^1\ I^3\ *n^4\ S^3$	vt	$*p^3\ N^4$
tu	$A^1\ *c^4\ U^3$	uu	$u^7\ s^7$	vu	$*u^3\ S^2$
tv	C^2	uv	$*i^3\ S^2$	vv	$U^7\ S^7$
ty	$a^6\ p^6\ t^3\ m^6$	uy	$e^6\ r^6\ n^6$	vy	$*a^3\ p^3\ *c^3\ t^5\ *r^3\ m^3$
tz	$c^6\ u^6$	uz	s^6	vz	$p^6\ c^6$

ya	$r^3\ m^3\ u^5$	za	n^3
yb	S^6	zb	r^3
yc	i^3	zc	$a^3\ *e^3$
yd	t^6	zd	$*t^6$
ye	s^6	ze	r^3
yf	$*a^3\ e^5$	zf	$e^6\ m^6$
yg	i^6	zg	$e^3\ r^3\ n^3$
yh	$*t^3\ r^5\ u^5$	zh	$a^6\ c^6$
yi	$i^6\ r^6$	zi	$*e^3\ r^3\ n^3$
yk	i^3	zk	r^6
yl	$c^3\ i^3\ r^5\ *m^3\ u^3$	zl	$u^7\ s^7$
ym	$T^5\ *r^3\ *m^3$	zm	$c^3\ n^3$
yn	$*t^3\ e^5\ n^5$	zn	$p^6\ c^6$
yo	a^3	zo	$e^6\ i^6\ s^6$
yp	$*c^3\ e^3\ *i^3\ m^3\ n^2$	zp	$p^6\ c^6$
yq	$*i^6$	zq	$e^3\ r^3\ n^3$
yr	$c^3\ i^3\ r^5\ *m^3\ u^3$	zr	$u^7\ s^7$
ys	$a^5\ c^5\ i^1\ m^5$	zs	p^6
yt	$c^6\ e^6\ i^6$	zt	$i^6\ n^6$
yu	$c^6\ m^6\ u^6$	zu	s^6
yv	$c^3\ *e^3\ *i^3\ m^3\ *n^3$	zv	$p^6\ c^6\ e^8$
yy	s^6	zy	$e^3\ r^3\ n^3$
yz	$c^3\ i^3\ *m^3\ u^3$	zz	$u^7\ s^7$

Table VII

THE VALUES FOR ENCIPHERING

In this Table are included all values given in Table VI, primary and secondary, without mark of distinction. Capitals indicate those values which are in common use and which alone, so far as possible, should be used in writing the significant letter-groups. [As in Table VI, the asterisk indicates values determined by the Editor, but not in the Author's copy of the Table; and the degree-sign indicates values listed elsewhere in the Author's writings, but not in his copy of the Table.][8]

A	AD	AL	BT	dn	FL	FR	fz	gf	GO	hp	HV	IF	IO	LC	lh
	*lk	LS	md	mf	MH	mq	MS	NB	NE	nf	nk	ny	oa	OD	OE
	ok	OL	OM	OR	oz	pa	pc	PE	pg	PI	pn	pq	py	qf	*qo
	rb	RC	rh	rk	sb	SC	SE	sg	sk	SQ	sy	TA	TE	tf	tg
	TO	tq	TU	ty	uc	uk	UD	VC	*vg	VI	vn	*vq	*vy	*yf	yo
	ys	zc	zh												78
P	AF	LN	LP	LT	md	nh	nl	NU	oa	OL	OP	pb	PE	PL	PT
	py	pz	RP	RV	SP	ST	SV	tg	TI	TO	TS	ty	UN	US	*vb
	VE	VR	*vt	vy	vz	zn	zp	zs	zv						39
C	AL	ao	AR	AS	az	bn	BO	bp	BU	BV	dm	dp	dv	EN	EP
	EU	EV	FA	fm	fn	fs	GL	°go	GR	gt	GU	gz	hn	ht	IL
	IR	it	IU	iz	lh	*lm	LN	LO	LP	ml	MP	mq	mr	MS	mz
	nb	ne	nk	nl	NM	NP	nu	nz	OC	od	om	OQ	OS	OT	OV

[8] [This Table had evidently not been thoroughly verified by the author, and it is probable that a few of the values given and not derivable, as in Table V.4°, are due to error; so also, some of the omissions are merely errors, which he would later have corrected.—RGK]

	pc	pg	pi	pk	PL	PO	pq	PR	PS	PU	PV	py	pz	ql	qm
	qr	qz	rb	rh	rm	RV	sb	se	sk	SN	ST	SU	sy	sz	ta
	tc	tf	tk	TL	tp	TS	*tu	TV	tz	ud	UN	vc	*vg	vi	vk
	VN	VO	*vq	VR	VS	*vy	vz	yl	*yp	yr	ys	yt	yu	yv	yz
	zh	zm	zn	zp	zv										125
T	AB	AF	ar	AU	AY	bd	bm	bn	cm	CN	CU	DA	dh	DI	dm
	dy	ED	EM	en	er	fb	FE	fg	FI	fm	fq	fy	gd	gh	GN
	gu	HA	hf	hm	hy	IH	IN	iu	ka	km	kn	LD	md	°mi	MR
	nh	OF	pb	py	qh	qm	qn	QU	RD	SH	TI	ty	UF	VB	vy
	yd	*yh	YM	*yn	*zd										65
E	af	AH	ak	AT	bf	BN	BS	dg	DO	DU	EF	EN	es	ft	FU
	gd	gp	GV	hl	HR	hz	ID	IP	IV	LA	LC	lf	LG	LI	LO
	lq	ly	MB	MC	md	ME	mf	mk	MO	MQ	my	NB	NC	ND	NE
	nf	NG	nh	NI	nk	NP	NQ	NV	*ny	OB	OG	OI	ok	OQ	OT
	oy	pa	pd	PE	PH	pm	qm	qp	*qv	RA	RC	RE	RF	RG	RI
	rm	RO	rq	ry	SA	SD	sf	sg	SL	SM	SQ	tb	TH	UA	UB
	°uc	ue	ug	ui	uk	UQ	UT	uy	VD	VF	VG	vh	vq	yf	yn
	yp	yt	*yv	zf	*zc	zg	*zi	zo	zq	zv	zy				116
I	AC	ao	AP	AQ	at	bc	bg	*bk	BL	bp	bq	BR	BS	BT	BV
	by	bz	cb	CC	CD	cf	CH	*ck	dm	dn	DO	dq	DS	DT	DU
	EC	eg	eh	ek	EL	EP	*eq	ER	ES	ET	EV	ey	ez	fa	fd
	FL	fm	fn	fp	FR	FT	FV	fz	gc	gk	GS	GT	hk	HL	hn

HO hp HR HU HV hz IA IC IE ik IO IP IQ IS IT
kc kd kf kh kk qb *qc qk qp *qv RO RT sl SO UP
UT *uv yc yg yi yk yl *yp *yq yr ys yt *yv yz zo
zt 106

R ab AE af AG ah AI AM an ao ap at ay BA bf BG
BH BI bm CL cp CR CS CV cz DF dg DH di dq dy
EA EG EH em EO ep ET FB GA GB gd GE GM gq GT
ha HB HD HE IA IB id IM kl kn ko kr ks ku kz
LB LE lg lh li lq ly MA mb md me MF MG MI mq
my na nb ND ne nf nh ob OD OH om oy PA pd pf
pg PI pm pq py qd qg qm qp QS QT qz RB RE rg
rh ri rq ry sa SB SE sf SG SI sy ta td tf th
ub UD ue UH uy VD vg vi *vq *vy ya yh yi yl *ym
yr zb ze zg zi zk zq zy 143

M AB AE af AG ah AI AM AN AS AT ay BA bf BG BH
BI bm bn BO BU by df dg dh di dm do dp dq du
dv dy EA EG EH em en es eu FA fb fd fm fn fs
ft GA gb gd GE gh GL GM gp gq GR gs GV gz ha
hb hd HE hl hn HR ht hz IA IB id IL IM ip IR
iv iz LF MA mb md me mf MG MI mo MP my NA nd
nh oa OI pb pe PH pq *py qd qg ql qm qp qr *qv
qz RF SD tb TE tg ti ty VB VE VF VG vh VQ vy
ya *yl *ym yp *yr ys yu yv *yz zf 130

N	af	at	bn	bs	CO	cp	CT	CV	do	du	en	es	fn	ft	gp
	gv	hl	hr	hz	ip	iv	kn	kp	ks	kt	kv	LA	LG	LI	*lm
	LQ	LT	ly	md	ml	MN	MO	mq	MR	mz	nb	NE	nf	nh	nl
	NS	NV	OB	°og	OP	*ov	oy	pd	pm	pn	qm	qo	qp	qv	RA
	RG	RI	RM	rq	ry	SA	sf	SM	SO	TH	UB	UE	UG	UI	UP
	*ut	uy	VD	VG	VP	vq	VT	yn	yp	*yv	za	zg	zi	zm	zq
	zt	zy													92
U	AI	ap	AS	BA	bc	bh	BI	BO	bp	bq	BU	CA	cb	CC	CE
	cg	CI	*ck	cl	CQ	cr	cy	cz	db	dc	DE	df	dk	DL	dm
	dp	DR	DV	dy	dz	EI	ep	eu	FA	fc	fh	fk	fm	fn	FO
	fs	FU	gb	GE	GL	GR	gs	gy	gz	hb	hc	hd	HE	hg	HI
	hk	hn	hq	hs	ht	*hy	IB	IL	IM	IR	IT	iy	iz	kb	kc
	ke	kg	kh	ki	kk	ko	kq	ky	LL	LR	LS	LU	LV	lz	MP
	NG	°ON	OO	OR	OS	OU	oz	PP	PU	qa	qc	qd	qe	qi	ql
	qr	qs	qy	qz	RR	rz	SS	tm	tn	TR	TT	TU	tz	uu	VA
	VM	*vu	VV	ya	yh	yl	yr	yu	yz	zl	zr	zz			132
S	aa	AN	AV	BB	BE	by	DD	EB	EE	ey	*ff	GG	GI	GM	GN
	hh	IG	II	LL	LU	lz	mg	MM	MN	*mr	MT	MU	MV	NA	NM
	NN	NO	nr	NT	nu	ON	OO	PP	qq	RL	RM	RN	RO	RR	RS
	RT	RU	rz	sl	sr	SS	TR	TT	UL	UM	un	UO	UR	UT	UU
	UV	uz	VL	VU	VV	yb	ye	yy	zl	zo	zr	zu	zz		73

Table VIII

THE VALUES AND FREQUENCY OF OCCURRENCE OF THE FIRST THOUSAND SYMBOLS OF *The Abbreviated Word about the Green Lion*

In the first thousand symbols of the treatise called *The Abbreviated Word about the Green Lion*, there are 173 different biliteral groups, the frequency of occurrence and the values of which are given in the following list:

Symbol	Occurrences	Values and Occurrences
1 ab	6	T 5, R 1
ac	4	I 4
ad	2	A 2
ae	6	R 4, M 2
ag	2	R 1, M 1
al	7	A 6, C 1
am	5	R 2, M 3
an	10	R 2, M 3, S 5
ap	2	I 2
aq	3	I 3
11 ar	8	C 7, T 1
as	4	C 2, M 2
at	19	E 10, M 1, N 8
au, av	6	T 4, S 2
ay	2	T 2
ba	3	R 1, U 2
bb	3	S 3
be	2	S 2
bi	9	R 3, M 6
br	6	I 6
21 bt	1	I 1
bu, bv	7	I 3, U 4
ca	4	U 4
cc	1	I 1
ce	3	U 3
ch	1	I 1
ci	7	U 7
cl	2	R 2
co	4	N 4
cr	2	R 2
31 cs	2	R 2
ct	3	N 3
cu, cv	12	T 8, R 1, N 3
da	2	T 2
de	11	U 11
di	14	T 14
do	2	E 2
du, dv	3	E 2, I 1
ea	3	R 2, M 1
eb	1	S 1
41 ec	9	I 9
ed	1	T 1
eg	4	R 3, M 1
ei	1	U 1
el	4	I 4
em	10	T 10
en	8	C 1, E 6, M 1
eo	5	R 5
er	28	T 2, I 26
es	9	I 9
51 et	13	I 8, R 5
eu, ev	6	C 2, I 3, U 1
fi	3	T 3
fl	1	I 1
fo	1	U 1
fr	4	A 2, I 2
ga	2	R 2
ge	6	R 2, M 4
gi	2	S 2
gn	2	T 1, S 1
61 go	2	C 2
gr	1	U 1
he	1	R 1
hi	4	U 4
ho	2	I 2
hr	1	E 1

Symbol	Occurrences	Values and Occurrences
ia	6	I 2, R 2, M 2
ib	3	R 1, M 2
ic	6	I 6
id	5	E 5
71 ig	2	S 2
ii	2	S 2
il	12	C 3, M 5, U 4
im	7	R 1, U 6
in	18	T 18
io	1	A 1
ip	5	E 1, I 4
iq	1	I 1
ir	3	C 3
is	35	I 35
81 it	15	C 1, I 5, U 9
iu, iv	6	C 2, E 4
la	8	E 4, N 4
lc	1	A 1
le	10	R 10
li	9	R 2, N 7
ll	5	U 4, S 1
ln	1	C 1
lo	2	E 2
lt	5	P 4, N 1
91 lu, lv	8	U 8
ma	7	R 1, M 6
mb	2	E 2
me	3	E 3
mi	5	T 2, M 3
mm	1	S 1
mn	5	N 1, S 4
mo	2	E 2
mq	1	E 1
mu, mv	5	S 5
101 na	3	S 3
nc	3	E 3
nd	5	E 4, R 1
ne	17	A 9, N 8
ng	2	E 1, U 1
ni	8	E 8
no	7	S 7
np	1	C 1
ns	3	N 3
nt	8	S 8

Symbol	Occurrences	Values and Occurrences
111 nu, nv	1	N 1
ob	3	N 3
oc	2	C 2
og	1	N 1
ol	7	A 2, P 5
om	7	A 6, R 1
on	12	U 12
op	4	P 3, N 1
or	10	A 1, U 9
os	3	C 2, U 1
121 ot	2	E 2
pa	1	R 1
pe	8	A 2, P 3, E 2, M 1
ph	4	E 4
pi	3	A 2, R 1
pl	2	P 1, C 1
po	4	C 4
pp	4	U 3, S 1
pr	4	C 4
ps	1	C 1
131 qu, qv	12	T 12
ra	13	E 3, N 10
rb	7	R 7
rc	1	A 1
rd	1	T 1
re	21	E 12, R 9
rg	2	E 1, N 1
ri	16	E 6, N 10
rm	1	E 1
ro	8	E 6, S 2
141 rs	1	S 1
rt	2	I 2
ru, rv	11	P 2, C 4, S 5
sa	1	N 1
se	8	A 1, R 7
si	6	R 6
so	9	I 5, N 4
sp	2	P 2
ss	6	U 3, S 3
st	11	P 3, C 8
151 su, sv	3	P 1, C 2
ta	13	A 12, C 1
te	9	A 8, M 1
th	1	N 1

Symbol	Occurrences	Values and Occurrences
ti	18	T 17, M 1
to	6	A 2, P 4
tr	7	U 5, S 2
tu, tv	18	A 5, C 4, U 9
ua, va	10	E 3, U 7
uc, vc	4	A 2, E 2
161 ud, vd	1	E 1
ue, ve	14	P 9, M 1, N 4
uf, vf	1	T 1
ui, vi	14	A 12, C 1, N 1
ul, vl	4	S 4
um, vm	33	U 19, S 14
un, vn	6	A 2, P 1, C 1, S 2
uo, vo	2	S 2
up, vp	2	I 1, N 1
ur, vr	7	P 1, S 6
171 us, vs	9	P 6, C 3
ut, vt	6	E 5, I 1
173 ym	2	T 2

Occurrences of the Values

A	79
P	45
C	64
T	106
E	109
I	148
R	91
M	47
N	81
U	139
S	91
Total	1000

Table IX

THE COMMUTED VALUES OF THE SYMBOLS

[As has been stated, in the shorthand text any letter which has as its partner in its symbol one of the letters *c o n m u t a* is commuted;[9] *q* had the same commuting value as *c*. That is, if the letter to be commuted stands first in its symbol, it is changed according to the conversion alphabet before its value is to be found: thus *et* is to be taken as *qt*, and has the value of *qt*. If the letter to be changed stands second, it is changed according to the reversion alphabet: so *te* becomes *ti* and has the value of *ti*. If both letters of the symbol are commuting letters, both are changed: thus *tq* must be read *pe*, and *nt* must be read *mo*.

This step in the decipherment may be eliminated by the use of the Table which follows, in which the symbols are commuted already, if subject to the process, and their new values are given. In the process of conversion, however, *s* is taken as converting only to *l* and *r*, not to *z*; *i* as converting to *b* and *e*, not to *y*; *m* as converting to *a*, not to *m*. In reversion, *m* converts only to *n*, not to *m*; *q* converts only to *e*, not to *a*.[10] Some symbols which contain *q* or commute to symbols containing *q*, are taken as though *q* were *c*; such values are marked by a superior *c*.

In this Table, capitals indicate values derivable and actually found in those of Newbold's work-sheets which have been examined for this purpose; italicized letters show values which he marked in Table VII as of common occurrence; roman minuscules are values which he marked in Table VII as of uncommon use.]

[9] [This Table has been compiled by the Editor.—RGK]

[10] [These limitations are based on various remarks of Newbold, found in his papers, and on the values which he gives in his work-sheets.—RGK]

aa	T R M U c e n *s*	ba	T r m	ca	t
ab	R M *u*	bb	S	cb	*u*
ac	I U r m s	bc	u	cc	*i u*
ad	*e* r m	bd	t	cd	I
ae	R M *u*	be	S	ce	U
ah	R M T	bh	R M u	ch	i u
ai	S	bi	R M *u*	ci	U
al	*c m u*	bl	*i*	cl	*r*
am	c *t* e *r m* n *u s*	bm	t	cm	T r n
an	*c t e* i *m* n u	bn	C M i u	cn	*t r n*
ao	C M i r *u*	bo	I	co	*r* u
ap	E R i *m* n	bp	C I U	cp	N
aq	I *r m u* s	bq	U	cq	U
ar	*c m u*	br	*i*	cr	*r* n
as	I r u	bs	E I N	cs	R n
at	A I c n	bt	C M u	ct	N r u
au	C I M e r *u*	bu	I *a*	cu	R *n* u
da	*c* i *m u*	ea	U	ha	T
db	u	eb	S	hb	R M u
dc	U	ec	I U	hc	U
dd	*s*	ed	*t*	hd	*r* m u
de	U	ee	S	he	R M *u*
dh	R M t	eh	R M i	hh	S
di	T r m	ei	U	hi	U
dl	U	el	I	hl	I e m n
dm	c t i m u	em	c t e r m n	hm	c t i m u
dn	c i m n u	en	T	hn	I a
do	*u*	eo	N a	ho	E *i* m n
dp	C M u	ep	C I R U	hp	A I
dq	t	eq	I° U° s	hq	R M U° i
dr	*u*	er	T I	hr	*e i m* n
ds	I	es	I e m n	hs	U
dt	E *i* m n	et	R	ht	I
du	U *e i*	eu	T e i m n	hu	C E M N *i u*

ia	R M *u*	la	M P a	ma	R M *s*
ib	R M *u*	lb	R	mb	*r m* t
ic	*i* u	lc	C	mc	*i*
id	E R m	ld	*t*	md	a
ie	I	le	R	me	t *r m*
ih	T	lh	R a c	mh	*e* r m
ii	S	li	N *e* r	mi	*r m*
il	C M *u*	ll	U *s*	ml	*a c*
im	*t* r m	lm	*a* c r	mm	r *m s*
in	*c* t *e* m n	ln	*u s*	mn	*t s*
io	R a *c m u*	lo	U S	mo	*a c*
ip	E *i* m n	lp	P C	mp	*s*
iq	I u	lq	C *e*	mq	*r m*
ir	*c m u*	lr	*u*	mr	*a c*
is	I	ls	A U	ms	*c m u*
it	I R a c e	lt	C E	mt	C I r
iu	C I *m u*	lu	U *c* n	mu	*c* t *e* i r m n

na	S	oa	u	pa	R N *e*
nb	E	ob	E *m*	pb	P T M
nc	a c *e* r	oc	a c	pc	A
nd	p t e r m n	od	R	pd	e r n
ne	E	oe	E *m*	pe	A P E m
nh	A c *e* r n	oh	N *e* r	ph	E m
ni	r *m s*	oi	P M a	pi	A R c
nl	N	ol	C U	pl	P C
nm	*n s*	om	u	pm	*e n*
nn	S	on	*a c* u	pn	C
no	N c	oo	C	po	I N
np	S	op	C E	pp	U s
nq	E r m	oq	A M	pq	A E
nr	N	or	C U	pr	C
ns	E *c*	os	P N	ps	C
nt	E m *n*	ot	A P	pt	P C
nu	C T N S	ou	U S	pu	C p

qa	T	ra	*e*	sa	E N
qb	U	rb	a c *r*	sb	A R c
qc	*i u*	rc	E a	sc	A *e*
qd	I° t	rd	*t*	sd	E *m*
qe	U	re	E R	se	A R c
qh	i	rh	a c r	sh	T
qi	U	ri	N *e* r	si	R
ql	R u	rl	S	sl	E S i
qm	*t*	rm	*s*	sm	c e r *n s*
qn	T *r n*	rn	*p c* s	sn	S *p c*
qo	R u	ro	S	so	C E I S
qp	R	rp	*p*	sp	P
qs	U	rq	E	sq	A° e r n
qr	R u	rr	S *u*	sr	s
qs	R e i m n	rs	*s*	ss	U *s*
qt	N	rt	E S *i* n	st	P I N S
qu	R *n* u	ru	U i *s*	su	U S *p c*

ta	R N e	ua	C S
tb	P T m	ub	A c e r *n*
tc	A c r m	uc	E
td	N *e* r	ud	R e m
te	P T m	ue	A E c r *n*
th	E m	uh	P M N t e r
ti	A c r	ui	E *u*
tl	P C	ul	P *c*
tm	A n	um	s
tn	C U	un	N *p* c *e* s
to	P C	uo	P C n
tp	U *s*	up	E S p *i* n
tq	A P E m	uq	A c *e* r *n*
tr	P C	ur	P *c*
ts	C	us	I N
tt	C	ut	S
tu	P C	uu	S

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